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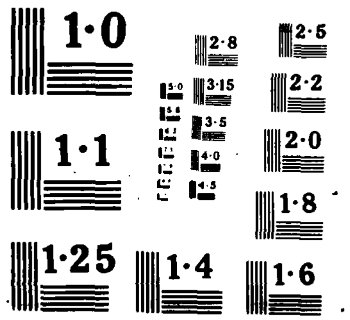
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SOUTH BRANCH ROOT RIVER
LANESBORO DAM-FILLMORE
COUNTY, MINNESOTA - INVENTORY
No. 517
NATIONAL DAM SAFETY PROGRAM
INSPECTION REPORT
July 1978

DOCUMENT IDENTIFICATION

INVENTORY

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The Lanesboro dam was originally constructed in 1868 by the Lanesboro Town Site Company. Presently, the dam is owned by the City of Lanesboro. The Lanesboro Dam is located near the center of the City of Lanesboro and is on the South Branch Root River. Many dwellings are located downstream of the dam on the right bank. These dwellings would likely suffer significant damage as a result of sudden failure of the dam during non-flood conditions, and loss of life would probably be highest during these conditions.

Evaluation of the dam included on-site inspection, a review of available plans and an evaluation of the hydraulic and hydrologic characteristics of the dam and reservoir. In addition, an evaluation of the operation and maintenance, geotechnical and structural aspects of the dam was made. The Lanesboro Dam is classified as a "high hazard" dam because of the proximity to downstream residential areas. However, if the measures recommended in this report are implemented, there would be a low threat of failure of the Lanesboro Dam.

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Mr. Ronning/hm/7955

NCSED-D

6 December 1978

SUBJECT: Dam Inspection Report, National Program of Inspection of Non-Federal Dams - Lanesboro Dam

Division Engineer, North Central
ATTN: NCDED-T

Inclosed for your files are a copy of the Lanesboro Dam Inspection Report, a copy of a letter sent to Governor Perpich, and a copy of a letter sent to the owner of the dam, the city of Lanesboro.

FOR THE DISTRICT ENGINEER:

3 Incl (See Roger R. for Incl 1)
as

ROGER G. FAST
Chief, Engineering Division

CF:
PA

RONNING ED-D
SCHULTZ ED-D
FLETCHER ED-D
BRAATZ PA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT. CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL. MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSED-D

6 December 1978

Honorable Rudy G. Perpich
Governor of Minnesota
130 State Capitol
St. Paul, Minnesota 55155

Dear Governor Perpich:

As part of the Dam Safety Inspection Program, the Lanesboro Dam, South Branch-Root River, was inspected on 30 May 1978. Inclosed is a copy of the inspection report. The inspection confirms the dam classification as "high hazard" because of the residential area that would be flooded by a failure of the structure.

You were informed on 1 June 1978 that a serious seepage condition existed in a dike. Corrective action was taken at that time by the Minnesota Department of Natural Resources to lessen the threat of failure. Several other deficiencies have also been identified in the report. In the interest of public safety, I recommend that the necessary engineering studies and remedial action be implemented to correct the deficiencies.

I would appreciate if the contents of this report would not be released to the public until 20 December 1978. This delay in release will allow time to forward copies for review by the owner. During this time, this report will be classified as an internal working paper not subject to release under the Freedom of Information Act. After thirty days from given date, the report will be subject to release upon request.

The Non-Federal Dam Inspection Program is a large investment by the Federal Government. I would appreciate being kept informed regarding implementation of the recommendations contained in the dam inspection report.

6 December 1978

If we may be of any further assistance in the matter, please do not hesitate to call on us.

Sincerely,

Forrest T. Gay III

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

ℓ' /4-0ι

Mr. Ronning/hm/7955

NCSED-D

6 December 1978

Honorable David R. Drake
Mayor of Lanesboro
ATTN: A. M. Halverson, City Clerk
Lanesboro, Minnesota 55949

Dear Mayor Drake:

As part of the Non-Federal Dam Inspection Program, your dam:

Lanesboro Dam
South Branch-Root River

was inspected on 30 May 1978. Inclosed are two copies of the inspection report.

This report is classified as an internal working paper not subject to release under the Freedom of Information Act until 20 December 1978 when Governor Perpich is permitted to release the contents of the report. Would you please review this report and inform me if you have further technical information that might affect the evaluation of the safety of the dam. If further information has an effect on the evaluation, a definite time period for comments will be added to the release date.

The inspection confirms the dam classification as a "high hazard" structure because of the residential area that would be flooded by a failure of the structure. On 1 June 1978, the Governor was informed of a serious seepage condition that exists in the dike. Corrective action was taken by you and the Minnesota Department of Natural Resources at that time to lessen the threat of failure. Several other deficiencies have also been identified in the report. In the interest of public safety, I recommend that necessary engineering studies and remedial action be implemented to correct the deficiencies.

The Non-Federal Dam Inspection Program is a large investment by the Federal Government. I would appreciate if you would keep the State of Minnesota informed regarding implementation of the recommendation-

NCSED-D
Honorable David R. Drake

6 December 1978

contained in the dam inspection report.

We thank you for your cooperation; and if we may be of any assistance in the matter, please do not hesitate to call on us.

Sincerely,

1 Incl (2 copies)
As stated

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

CF:

PA

RONNING ED-D
SCHULTZ ED-D
FLETCHER ED-D
CALTON ED-PB
BRAATZ PA
FAST ED
HEME DDE

Mr. Ronning/hm/7955

NCSED-D

6 December 1978

Mr. Gene Hollenstein
Minnesota Department of Natural Resources
Division of Waters
444 Lafayette Road
St. Paul, Minnesota 55101

Dear Gene:

One copy of the Lanesboro Dam Inspection Report has been sent to the Governor and two copies to the owner. Inclosures 1 and 2 are copies of letters that accompanied the reports. They were asked not to release the contents of the report to the public until 20 December 1978. If any information obtained has an effect on the safety of the dam, a definite time period will be added to the release date.

To help the Corps keep abreast on implementation of the recommendations in the dam inspection report, the Governor and the owner were asked to keep the Corps or the State informed of the action taken on the recommendations. We ask your help in keeping the Corps informed of any new information that you may receive.

Also inclosed are four copies of the stated dam inspection report for your files and distribution.

We thank you for your cooperation and assistance in the production of this report.

Sincerely,

ROGER E. RONNING
Program Manager
Dam Safety Program

3 Incl
1. Cpy ltr to Governor
2. Cpy ltr to Owner
3. 4 Copies of Report

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Number Received 10

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AS RM

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT. CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL. MINNESOTA 55101

REPLY TO
ATTENTION OF: NCSDE

1 June 1978

Honorable Rudy G. Perpich
Governor of Minnesota
130 State Capitol
St. Paul, Minnesota 55145

Dear Governor Perpich:

As you are aware the Department of Natural Resources and the Corps of Engineers are currently conducting a cooperative program of dam safety inspections in the State. On 30 May our inspection team and representatives of the Department of Natural Resources visited the Lanesboro Dam on the Root River in Lanesboro, Minnesota. Their inspection revealed a serious seepage condition on a dike located downstream of the main dam. The dike forms the side of a canal which conducts water from the main dam area to the power generation facilities. The flow from the main dam area to the canal is controlled by gates which are located upstream of the seepage area. A failure of this dike therefore would not involve a loss of the entire reservoir but only the water located in the canal downstream of the gates at the main dam.

Based on a visual inspection of the area, it is our belief that a failure of the dike would not pose a significant threat to life and personal property downstream of the dam. However, due to the accumulation of silt in the canal, such a failure may result in a serious degradation of the water quality downstream of the dam.

We do not consider this condition to represent an emergency situation, but in view of the potential economic and environmental loss we recommend that the owner initiate prompt remedial action to correct the seepage problem.

If we may be of any further assistance in this matter please do not hesitate to call on us.

Sincerely,

Forrest T. Gay III

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

cf: City of Lanesboro

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT. CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL. MINNESOTA 55101

REPLY TO
ATTENTION OF: NCSDE

1 June 1978

Honorable David R. Drake
Mayor of Lanesboro
Lanesboro, Minnesota 55949

Dear Mayor Drake:

As you are aware the Department of Natural Resources and the Corps of Engineers are currently conducting a cooperative program of dam safety inspections in the State. On 30 May our inspection team and representatives of the Department of Natural Resources visited the Lanesboro Dam on the Root River in Lanesboro, Minnesota. Their inspection revealed a serious seepage condition on a dike located downstream of the main dam. The dike forms the side of a canal which conducts water from the main dam area to the power generation facilities. The flow from the main dam area to the canal is controlled bv gates which are located upstream of the seepage area. A failure of this dike therefore would not involve a loss of the entire reservoir but onlv the water located in the canal downstream of the gates at the main dam.

Based on a visual inspection of the area. it is our belief that a failure of the dike would not pose a significant threat to life and personal property downstream of the dam. However, due to the accumulation of silt in the canal, such a failure may result in a serious degration of the water quality downstream of the dam.

We do not consider this condition to represent an emergency situation, but in view of the potential economic and environmental loss we recommend that the City of Lanesboro, the owner, initiate prompt remedial action to correct the seepage problem.

If we may be of any further assistance in this matter please do not hesitate to call on us.

Sincerely,

Forrest T. Gay III

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

NATIONAL DAM SAFETY PROGRAM REPORT

LANESBORO DAM MN 517

SOUTH BRANCH ROOT RIVER

FILLMORE COUNTY, MINNESOTA

JULY 1978

APPROVED: Forrest T. Gay III Date 14 Nov 78
DISTRICT ENGINEER

Roger G. Fast Date 7 Nov 78
CHIEF, ENGINEERING DIVISION

TECHNICAL REVIEW: [illegible] Date 11/6/78
CHIEF, DESIGN BRANCH

Peter A. Fischer Date 6 Nov 78
CHIEF, HYDRAULICS ENGINEERING
AND FOUNDATION MATERIALS BRANCH

SUBMITTED BY: [illegible] Date 6 Nov 1978
PROJECT MANAGER, DAM SAFETY PROGRAM

TABLE OF CONTENTS

GENERAL SUMMARY

The procedures and methodology used for dam design have undergone major evolution within the last half century. Because the majority of dams within the state were constructed during or prior to this evolution, often there is little available design information which conforms to current practice. The emphasis of the National Dam Inspection Program is not to develop the data and analyses necessary for a comprehensive analysis of a structure, but rather to identify conditions which constitute an existing or potential hazard. By necessity, the identification process presented in this report is generally limited to conditions which may be identified through the field inspection, approximate computations and other readily available sources of information. The contents of this report should, therefore, not be treated as an in-depth engineering evaluation.

The Lanesboro Dam was originally constructed in 1868 by the Lanesboro Town Site Company, a joint stock company formed in New York to build the village. The dam was constructed for the purpose of developing the water power available at the site and thereby attracting industry to the village. Three flour mills operated on water power downstream of the dam in the 1870's, but were all demolished by fire prior to the mid-1890's. In the mid-1890's, the village built its first hydro-electric generating plant on a site of one of the demolished mills. Since that time, hydro-electric power has been generated at the site on a relatively continuous basis. Presently, the dam is owned by the City of Lanesboro. At the present time, the powerhouse contains one active 250 KVA turbine/generator and one inactive unit.

The Lanesboro Dam is located near the center of the City of Lanesboro and is on the South Branch Root River. Three thousand to 5,000 feet downstream of the dam on the right bank are many dwellings which would likely suffer significant damage as a result of a sudden failure of the dam. These dwellings are not sufficiently above the river and would likely suffer significant damage as a result of a sudden failure of the dam during non-flood conditions. The loss of life probably would be the highest during a sudden failure under non-flood conditions. Failure of the dam during an unusually high flood condition would probably not result in significant downstream damage nor an increased loss of life. Several bridges downstream of the dam, however, could suffer significant damage both during flood and non-flood failure of the dam.

CONCLUSIONS AND RECOMMENDATIONS

Evaluation of the dam included an on-site inspection, a review of available plans and an evaluation of the hydraulic and hydrologic characteristics of the dam and reservoir. In addition, an evaluation of the operation and maintenance, geotechnical and structural aspects of the dam was made. The following are the major conclusions and recommendations resulting from the evaluation.

1. Discharge Capacity

The size and number of waterway outlets at the dam are insufficient to allow the complete discharge of large flood flows. This lack of discharge capacity would cause the reservoir level upstream of the dam to rise to a height above the ground adjacent to the dam. Under these conditions, reservoir water would flow over the canal embankment adjacent to the spillway and erode a channel which may lead to failure of of the canal embankment.

The water would probably continue to erode until the bottom of the breach reached solid bedrock. At this point, the depth of the eroded channel would essentially remain constant for the duration of the flood. The failure of the canal embankment would permit an uncontrolled flow of water to pass from the reservoir into the downstream areas. Approximate computations indicate that the chance of this occurring in any given year is 6.0 percent. The failure of the canal embankment is not expected to significantly increase either the extent of property damage or the possibility of loss of life.

The currently accepted dam safety criteria indicate that because the Lanesboro Dam is within the "intermediate" size and "high" hazard classifications, the structure should be designed to have the ability to pass the Probable Maximum Flood without failure. However, because it is believed that the hazard to downstream life and property is greatest during normal flow and moderately severe flood conditions, the hazard becomes less significant at flood levels approaching the Probable Maximum Flood (PMF). No recommendation is made regarding

modification of the facility to provide for passage of the PMF without failure. It is recommended that a spillway design flood be determined on the basis of more detailed evaluations of the hydrology, hydraulics and downstream damage potential to the dam and appurtenant structures and that such modifications as required to allow safe passage of the design flood be implemented.

2. Operating Plan

The owner of the Lanesboro Dam currently has no documented plan for regulating the powerhouse. However, the discharge capacity of the powerhouse is insignificant with respect to the river flow during major floods. However, it is recommended that a documented hydraulic operation manual be developed and implemented formally defining the capabilities of the powerhouse and canal intake structures.

It is recommended, that a documented plan be developed for closing the various bridges downstream of the dam during major flooding and warning the populace of the hazardous conditions which exist near the river during flood conditions.

Because at present, operation of the turbine is controlled by use of the wicket gates or canal intake structure, it is recommended that the intake to the powerhouse be repaired.

3. Inspection and Maintenance Program

No systematic program of periodic inspection has been developed for the dam. Since a continuing program of inspection is a necessary part of an effective maintenance program, it is recommended that such an inspection and maintenance program be developed and implemented.

4. Embankment Stability and Seepage

The most critical problem that currently exists at the Lanesboro Dam is excessive seepage within the earth embankment along the left abutment of the canal spillway. The seepage is resulting in piping,

which is now in progress, and may breach the embankment. It is recommended that the earth embankment and the left abutment adjacent to the canal spillway be investigated in more detail with respect to seepage and piping and appropriate repairs effected. It is further recommended that this investigation be performed as soon as possible.

Based on the previous history of seepage problems and the presence of conduits through the embankment near the powerhouse, it is recommended that the conduits be located and investigated to determine the potential for excessive seepage which may lead to stability problems.

The earth embankments are probably stable provided seepage is controlled. However, portions of the embankments do not meet the current design criteria in all respects. In addition, seepage adjacent to the canal spillway and upstream of the powerhouse is present. Therefore, it is recommended that the stability of the earth embankment adjacent to the left abutment of the canal spillway be investigated in more detail and appropriate action taken to correct any stability problems which are discovered. It is known that this portion of the embankment does not meet current design criteria with respect to crest width and maximum slope. It is, therefore, recommended that the crest width be increased and the downstream slope flattened in accordance with the current design criteria. It is recommended that the earth embankment adjacent to the powerhouse be investigated in more detail to determine if it satisfies current design criteria with respect to slope stability. This investigation should be undertaken in conjunction with the previously recommended seepage investigation. It is recommended that the earth embankments be monitored for signs of instability, such as seepage and erosion, on a regular basis, as a part of a regular inspection program and appropriate action taken if evidence of instability is observed.

5. Surface Conditions of the Embankment

Trees and brush are present on the embankments. Due to the potential for loss of embankment material as a result of wind-downed trees and the potential for piping to develop along roots, the presence of

trees on an embankment is usually considered to be undesirable. However, due to the thickness of the embankments, it is not evident that the trees and brush represent a potential hazard to the safety of the embankments. No recommendation for removal of the trees and brush is made.

6. Erosion and Scour Protection

The existing scour downstream of the spillway is a potential problem which could lead to serious structural problems. It is recommended that the scour hole be repaired and that the crest of the dam be made uniform to prevent concentrated flow.

7. Structural Stability

A preliminary analysis indicates that the primary spillway depends upon arch action to maintain stability. The concrete crest and the "cramps" tend to insure that arch action is achieved. It is recommended that a more detailed investigation and analysis be performed to fully explore the structural stability of the Lanesboro Dam. It is recommended that the concrete cap on the spillway be repaired as soon as possible since displacement of the stones in an arch could precipitate a progressive failure of the dam.

The canal intake structures show signs of displacement. It is recommended that the cause of displacement be evaluated and appropriate action taken.

8. Hazard Classification and Threat

The Lanesboro Dam has been previously classified as a "high hazard" dam because of the proximity to downstream residential areas. This report agrees with this classification. It is likely that downstream residential areas will be affected by a failure of the dam and property

damage along with a potential loss of life would result. However, if the measures recommended in this report are implemented, there would be a "low threat" of failure of the Lanesboro Dam.

SIGNATURES OF INSPECTION TEAM

BARR ENGINEERING CO.

INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LANESBORO DAM, INVENTORY NO. 517
SOUTH BRANCH ROOT RIVER, MINNESOTA

SECTION 1
PROJECT INFORMATION

1.1 GENERAL

a. Authority

The FY 1978 Public Works Appropriation Act, P.L. 95-96.
The National Dam Inspection Act, P.L. 92-367, 8 August 1978.

b. Purpose of Inspection

The purpose of this inspection is to make an assessment of observed conditions which may affect the integrity of the structure and thereby create a hazard to the public.

c. Methodology

The process involved in this section consists of two on-site inspections, an office evaluation of conditions noted in the field and a report on the inspections and office evaluation. On 30 May 1978, the inspection team conducted a routine on-site visual evaluation of the structure. On 6 July 1978, members of the inspection team conducted a special on-site visual evaluation of the structure during flood conditions.

The Report of Field Inspection (see Appendix A) summarizes the routine on-site observations and opinions of the inspection team. Photographs taken during the inspection are included in Appendix C. The office evaluation consisted of collection and review of the existing data to substantiate and refine the on-site observations of the team. Therefore,

contradictions may be found between the Report of Field Inspection and this report.

1.2 DESCRIPTION OF PROJECT

a. General

The components of the Lanesboro Dam include a primary spillway approximately 193 feet long. Constructed of stone masonry in an arch across the main channel of the river, it has abutments and a masonry non-overflow section on the left side. A canal intake structure, located on the left* of the spillway, controls the inlet of the canal on the left bank and a segment of the stone masonry non-overflow section is located immediately downstream. A stone masonry arch canal spillway and earth embankment are located between the masonry stone left abutment and the railroad grade. An earth embankment railroad grade, which crosses the canal, separates the canal from the river. A powerhouse with intake and an outlet is located approximately 1,000 feet downstream for the dam on the left bank of the river.

The principal components are discussed in the following paragraphs:

The primary spillway is of masonry stone arch construction and is reportedly founded on bedrock. The ends of the arch terminate at bedrock outcrops on both sides of the main river channel. On the left end of the primary spillway, a short non-overflow section lies between the end of the uncontrolled crest and the canal intake structure. The non-overflow section is about 2-1/2 feet higher than the crest. The crest of the primary spillway has a partially eroded concrete cap approximately 4 feet horizontal in width. The cap then extends on a slope of approximately 2 foot horizontal to 1 foot vertical, upstream another 4 or 5 feet. The vertical distance from the crest to the downstream channel bed is about 25 feet. The overall hydraulic height from the channel bed to the top of the canal intake structure (determined to be the top of the dam in this report) is approximately

*Right and left are defined by facing downstream.

34 feet. The spillway is constructed from stone blocks which were reportedly quarried near the site of the dam, probably from the railroad cut to the left of the dam. The downstream face of the spillway appears to be nearly vertical and water falling over the spillway impinges in a pool eroded in the bedrock. Soundings taken in the course of this inspection during low flow conditions indicate that the depth of the plunge pool near the downstream face of the spillway varies from approximately 4 to 4-1/2 feet on the right side of the spillway to approximately 10 to 11 feet on the left side of the spillway.

The canal intake structure is a gravity structure apparently originally constructed of rock masonry and subsequently filled and capped with a concrete slab. The structure contains three vertical slide gates, which control the inlet to the canal. These gates are apparently constructed of timber and are set in slides on the upstream face of the structure.

The non-overflow section, which lies between the left abutment of the primary spillway and the canal intake structure, is also of stone masonry construction. The downstream end of the non-overflow section terminates in a bedrock outcrop. The upper portion of the downstream end of the non-overflow section terminates in the connection between the canal intake structure and the downstream non-overflow section.

The appurtenances to the La[illegible]boro Dam include the canal spillway, which is immediately downstream of the non-overflow section, and is also of stone masonry arch construction. The upstream end of the canal spillway terminates at the non-overflow section downstream of the canal intake structure. The downstream end of the canal spillway terminates in a rock masonry abutment constructed approximately perpendicular to the axis of the canal. The downstream or river side face of the canal spillway has been protected by a concrete wall approximately 18 inches thick at the top, reportedly containing horizontal and vertical reinforcing. The vertical reinforcing is reportedly drilled and grouted into the rock foundation. The canal, which extends between the dam and the powerhouse along the left bank of the river, is formed by an earth and/or rock fill embankment on its right side adjacent

to the river. The embankment was formerly a railroad grade. Near the downstream end of the canal, the left side of the canal is formed by an embankment through the mill pond. This embankment is constructed of unknown material.

The powerhouse is located at the downstream end of the canal and consists of a masonry superstructure supported on a concrete substructure. At this time, the powerhouse contains one active 250 KVA turbine/generator and one inactive unit. Water is directed from the canal to the turbine by a penstock. The flow through the turbine is controlled by wicket gates in the turbine and a vertical slide gate in the canal inlet structure. After passing through the turbine, the water is transmitted to the river through a second conduit or draft tube. The facility also has a second control structure at the end of the canal, which probably was, or is, connected to a turbine in one of the old (now non-existent) mills. At this time, the second control structure can reportedly be used for dewatering the canal.

b. Location

The Lanesboro Dam is located on the South Branch of the Root River within the corporate limits of the City of Lanesboro. Lanesboro is approximately 50 miles east of Austin, 30 miles southwest of Winona, and approximately 130 miles southeast of Minneapolis-St. Paul. The dam is located in Sections 13 and 24, T103N, R10W.

c. Size Classification

The maximum design storage capacity of the Lanesboro Dam is approximately 1,000 acre-feet and the current hydraulic height is approximately 33.6 feet, measured from the natural bed of the stream downstream to the top of the dam. This places the dam in the intermediate size category.

d. Hazard Classification

High (see Section 3).

e. Ownership

The City of Lanesboro, Minnesota is the owner of the Lanesboro Dam.

f. Purpose

The Lanesboro Dam, previously used to develop water power for milling, is now used to develop water power for the municipal hydro-electric plant.

g. Design and Construction History

The Lanesboro Dam was originally constructed in 1868 by the Lanesboro Town Site Company. The dam was constructed for the purpose of developing available water power to attract industry to the village. Three flour mills were developed in the 1870's, but were destroyed by fire prior to the mid-1890's. In the mid-1890's, the village constructed its first hydro-electric plant at the site of one of the demolished mills and hydro-electric power has been generated at the site on a relatively continuous basis since that time.

Very little maintenance to, or modification of, the original dam and its appurtenances has been conducted. The original hydro-electric plant was replaced with the existing plant in 1922. The concrete cap on the canal intake structure and the concrete cap on the crest of the primary spillway were likely constructed at a later date. In 1972, deterioration of the downstream or river side of the canal spillway downstream from the canal intake structure was repaired by the construction of a concrete wall on the downstream side of the canal spillway.

h. Normal Operating Procedures

Water from the Root River is diverted through the canal to the powerhouse for the generation of hydro-electric power. The one small turbine which is currently operable, is usually operated between the hours of 8 a.m. and 4 p.m. by plant personnel.

1.3 PERTINENT DATA

a. Discharge Area — 297 square miles

b. Discharge at Dam Site (cfs)

Maximum Known Flood at Dam Site	14,300 (estimated)
Warm Water Outlet at Pool Elevation	Unknown
Diversion Tunnel Low Pool Outlet at Pool Elevation	N.A.
Diversion Tunnel Outlet at Pool Elevation	N.A.
Gated Spillway Capacity at Pool Elevation	N.A.
Gated Spillway Capacity at Maximum Pool Elevation	N.A.
Ungated Spillway Capacity at Maximum Pool Elevation	16,700
Total Spillway Capacity at Maximum Pool Elevation	16,700

c. Elevation (Feet above M.S.L.)

Top of Dam (top of canal intake structure)	855.6±
Maximum Pool Design Surcharge	855.6±
Full Flood Control Pool	N.A.
Recreational Pool	847.0±
Upstream Portal Invert Power Tunnel	N.A.
Downstream Portal Invert Power Tunnel	N.A.
Streambed at Centerline of Dam	822±
Maximum Known Tailwater	835± (14,300 cfs)
Top Overbank Upstream of Dam	851.0±
Top Right Abutment	851.0±
Top Primary Spillway	847.0±
Top Left Abutment	852.5±
Top Canal Intake Structure	855.6±
Top Non-Overflow Section (upstream)	852.3±
Top Non-Overflow Section (downstream)	850.9±
Top Canal Spillway	848.3±

Top Canal Spillway Abutment	850.7$\pm$
Top Earth Embankment	849.0$\pm$
Top Canal Embankment	849.5$\pm$

d. Reservoir (miles)

Length of Maximum Pool at Top of Dam	4.1
Length of Recreational Pool	2.6
Length of Flood Control Pool	N.A.

e. Storage Design Values (acre-feet)

Recreational Pool	110
Flood Control Pool	N.A.
Design Surcharge	890
Top of Dam	1,000

f. Reservoir Surface (acres)

Top of Dam	205
Maximum Pool	N.A.
Flood Control Pool	N.A.
Recreational Pool	31
Spillway Crest	31

g. Dam

Type	Stone masonry arch spillway and stone masonry non-overflow section arch secondary spillway
Length of Right Earth Embankment	N.A.
Length of Right Abutment	4$\pm$ feet
Length of Overflow Section	193$\pm$ feet
Length of Left Abutment and Upstream Non-Overflow Section	18$\pm$ feet
Length of Canal Intake Structure	60$\pm$ feet
Length of Downstream Non-Overflow Section	32$\pm$ feet

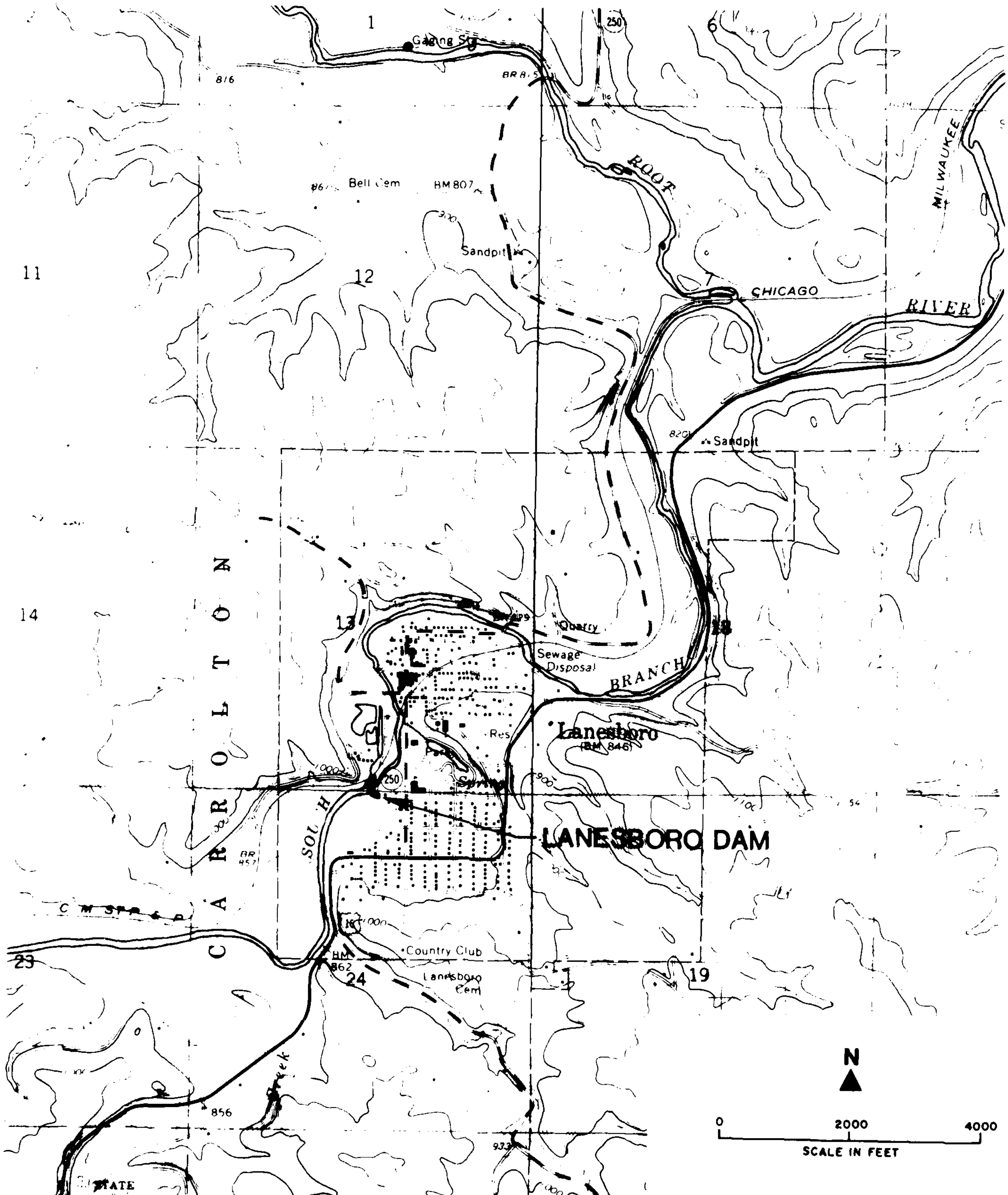
Length of Canal Spillway	84± feet
Length of Earth Embankment	60± feet
Length of Canal	1,000± feet
Total Length of Dam (not including appurtenances)	275± feet
Maximum Height (hydraulic)	33.8 feet
Side Slopes	See Plates
Zoning	Unknown
Foundation	Unknown
Impervious Core	Unknown

h. Spillway (primary)

Type	Uncontrolled overflow
Stilling Basin	N.A.
Length of Weir	193 feet
Crest Elevation	847.0±
Gates	N.A.
Upstream Channel	Earth embankment
Downstream Channel	Bedrock with silt overbank

i. Outlet Works

Type	Canal with intake structure controlling canal and powerhouse
Regulating Facility	3 wood slide gates - size unknown
Canal Intake Structure Invert	837.3±
Invert Penstock	834.9±
Outlet Invert	817.6±
Tailwater at Outlet (day of inspection)	819.9±



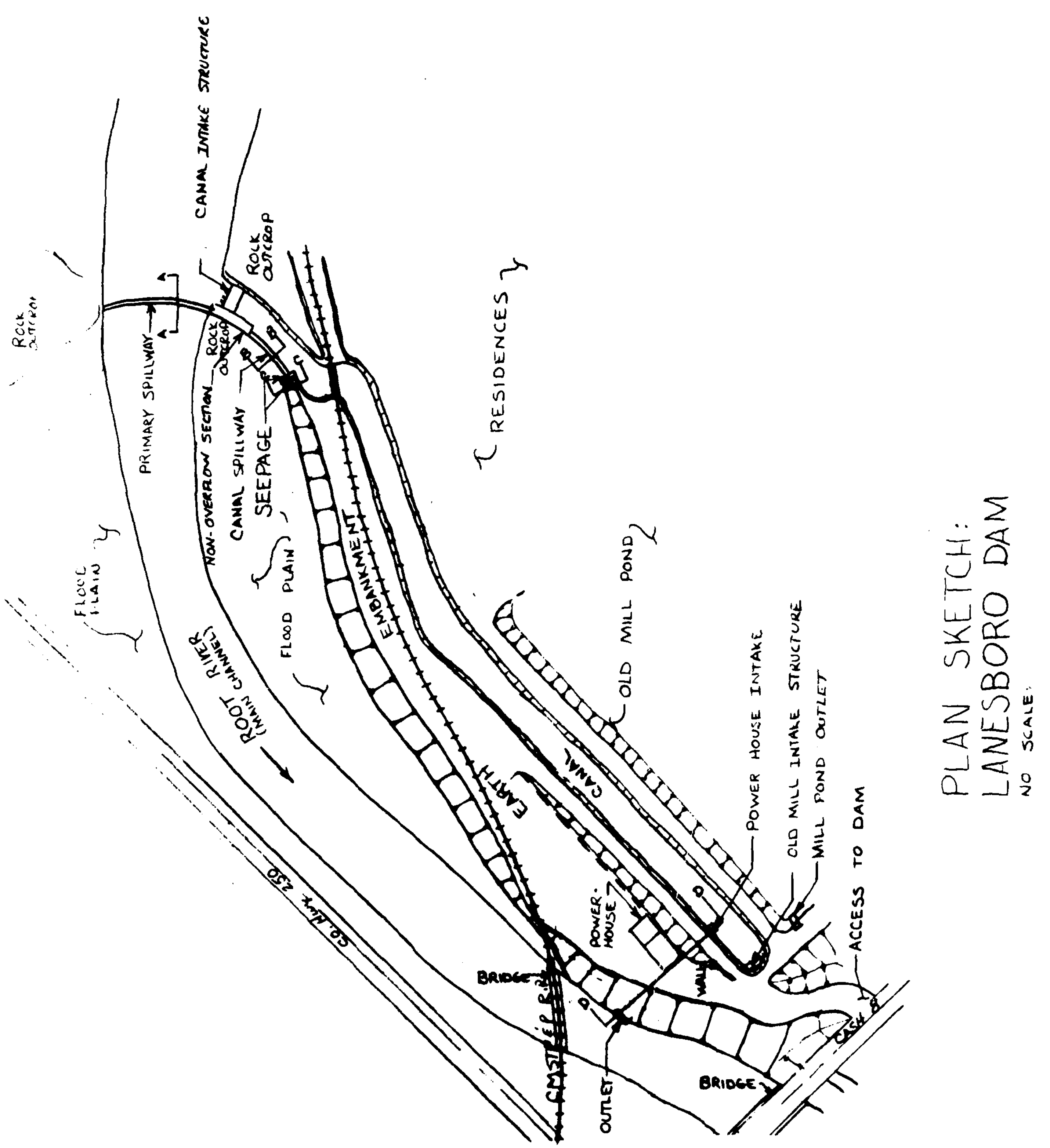
NATIONAL DAM SAFETY PROGRAM

SOUTH BRANCH ROOT RIVER

LANESBORO DAM

JULY, 1978

Plate 1-1

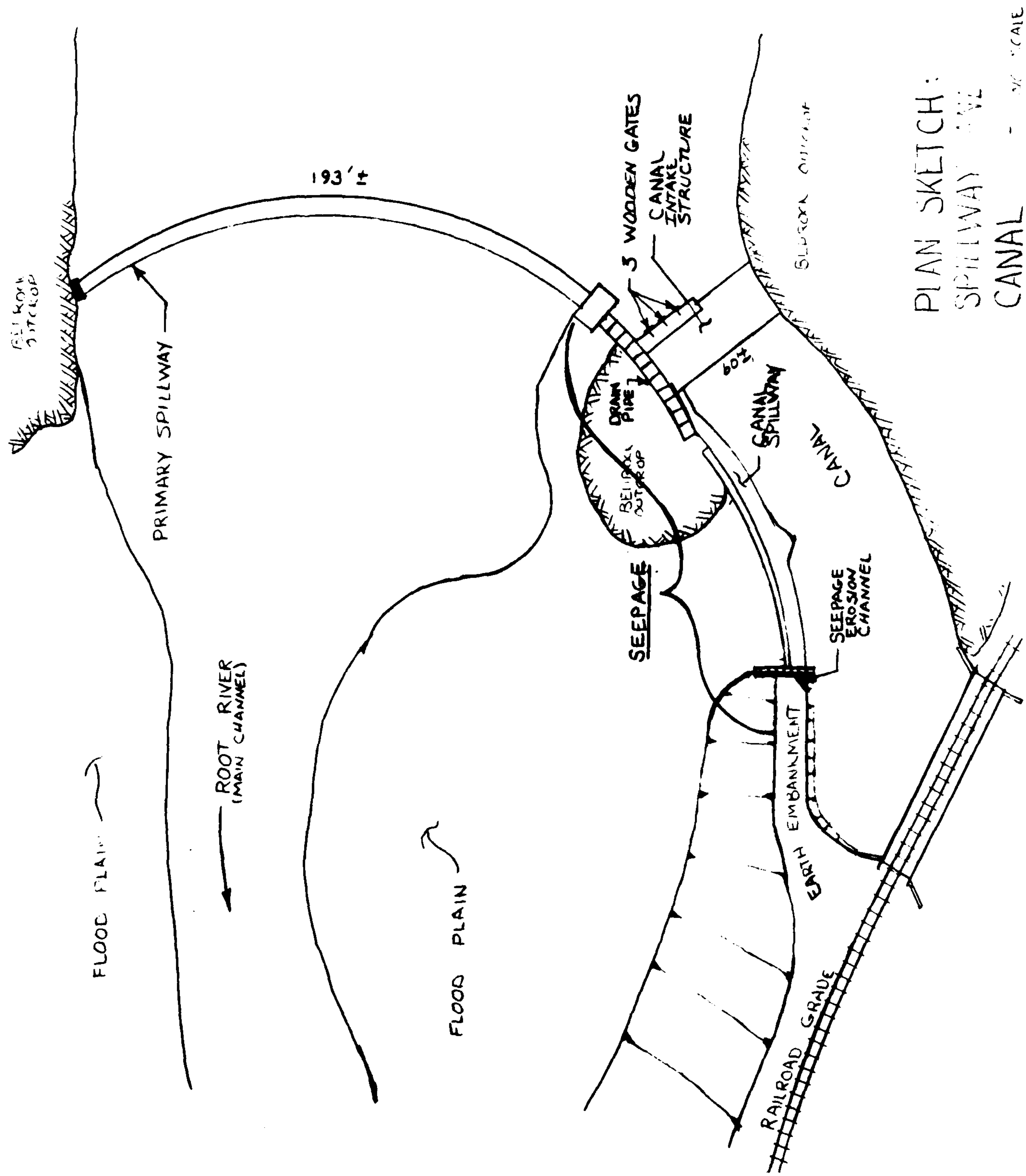


NATIONAL DAM SAFETY PROGRAM

SOUTH BRANCH ROOT RIVER

LANESBORO DAM

July, 1978



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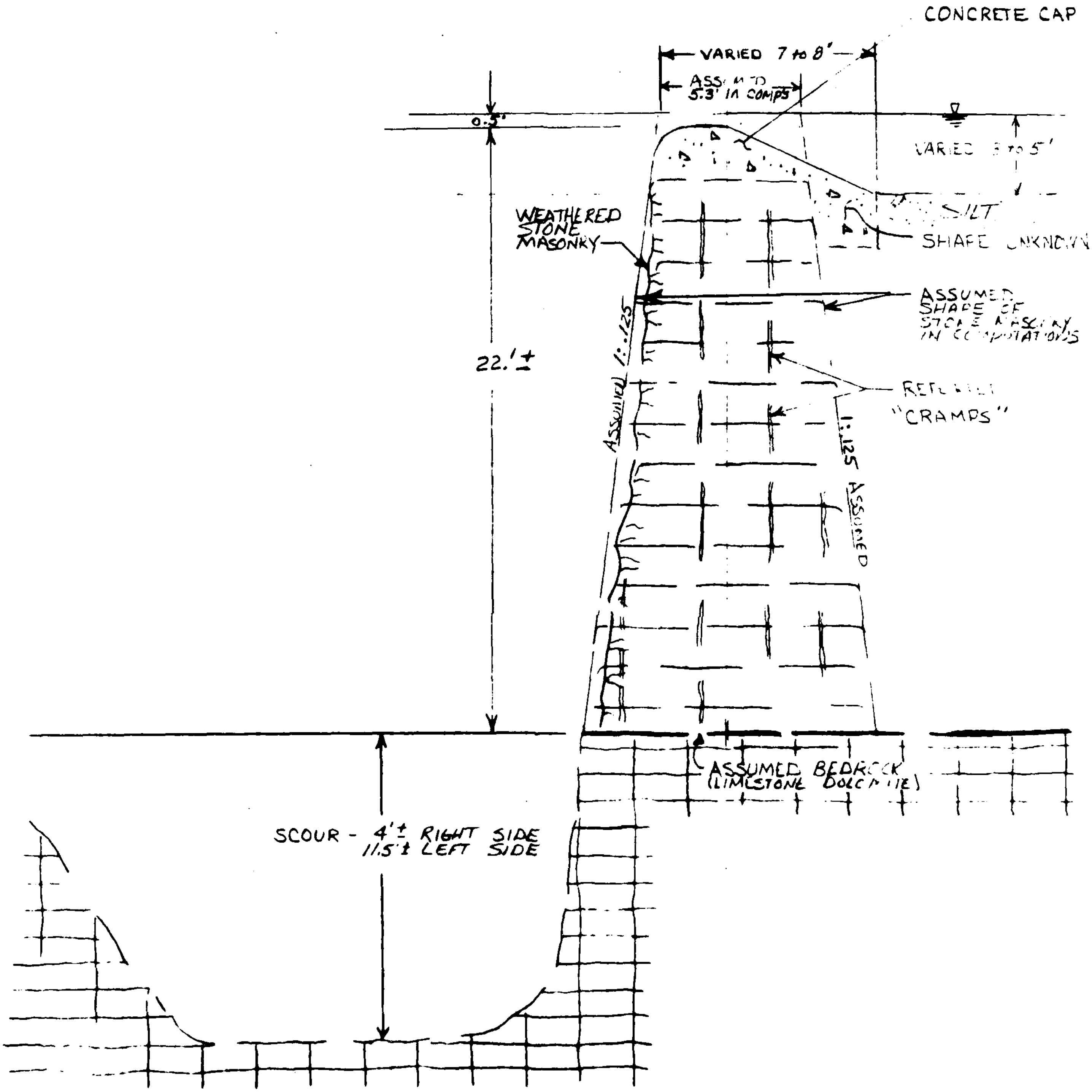
SOUTH BRANCH ROOT RIVER

LANESBORO DAM

July, 1978

Plate 1-3



SECTION A-A · SPILLWAY

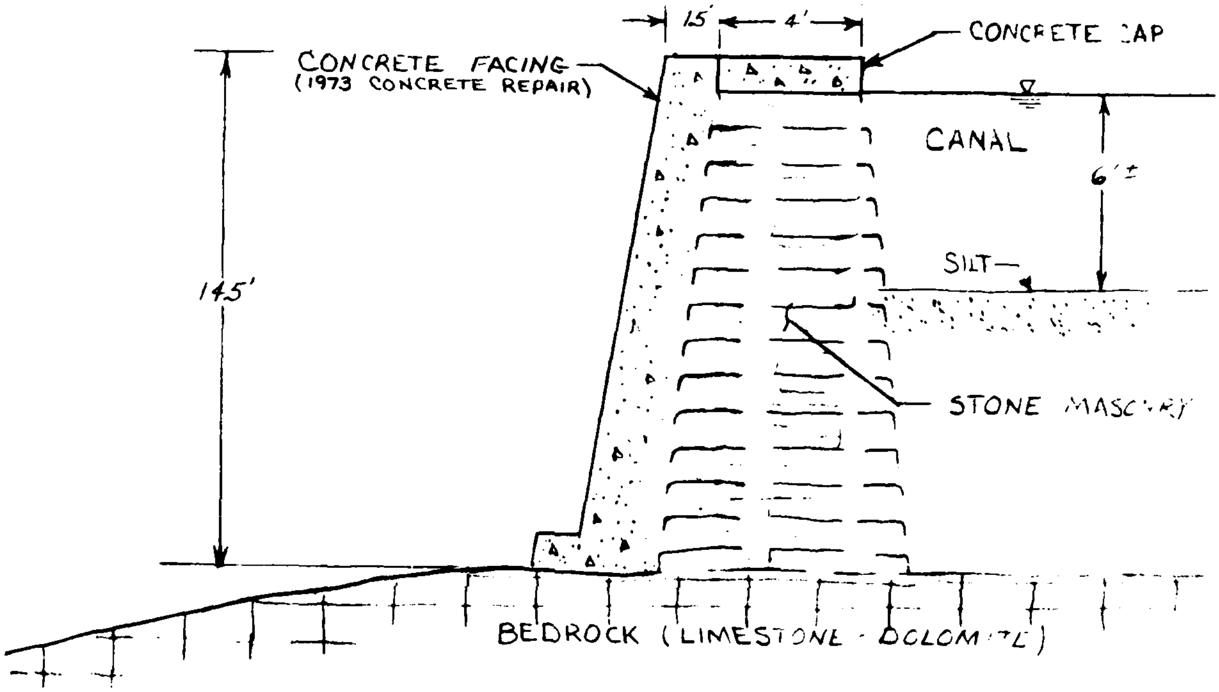
SCALE : 1" = 5'

NATIONAL DAM SAFETY PROGRAM

SOUTH BRANCH ROOT RIVER

LANESBORO DAM

July, 1978



SECTION B-B - SECONDARY SPILLWAY

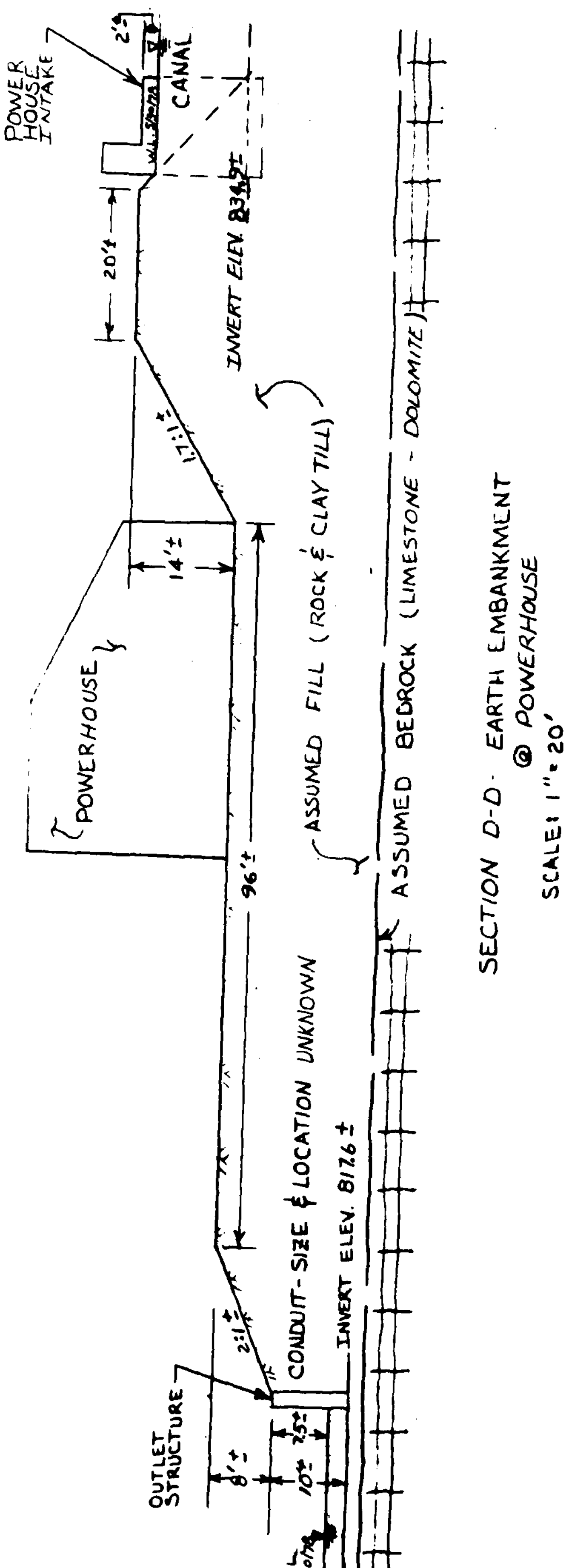
SCALE: 1" = 5'

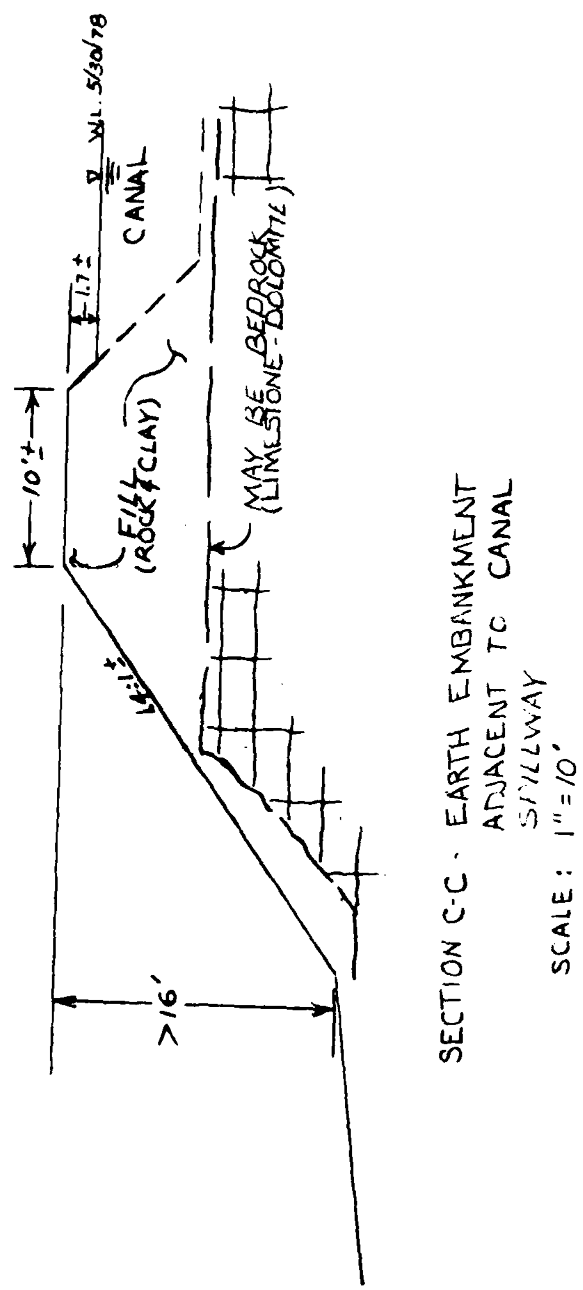
NATIONAL DAM SAFETY PROGRAM

SOUTH BRANCH ROOT RIVER

LANESBORO DAM

July, 1978





NATIONAL DAM SAFETY PROGRAM
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
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SECTION 2
BACKGROUND ENGINEERING DATA

2.1 HISTORY

The Lanesboro Dam, located within the corporate limits of Lanesboro, Minnesota, was reportedly constructed in 1868. The information in this section is based on information obtained from interviews with Mr. Lloyd Smith, Superintendent of Utilities for the City of Lanesboro and from the publication, River Valley Echos by Charles R. and Bienna L. Drake, published by Whiting Printers and Stationers, Rochester, Minnesota, in 1969 for the celebration of Laneboro's centennial year. An approximate chronology of major construction events associated with the dam follows:

1868 - Lanesboro Dam was originally constructed by the Lanesboro Town Site Company for the purpose of developing water power at the site. Lanesboro was plotted in 1868 and the railroad was constructed through Lanesboro in 1868. It was reported that the dam was constructed during the cold winter of 1868 by Mr. Dennis Galligan, who moved to Lanesboro in 1867. It is believed the limestone blocks for the dam were obtained from the railroad cut adjacent to the spillway. Because the construction of the dam and the railroad occurred during the same period, it is believed that the construction of the dam, the railroad, and the mill pond were part of a simultaneous project.

1870's - Three flour mills were developed downstream of the dam along the canal and operated by water power. The embankments along the existing canal appear to have been used as railroad grade, as depicted by a picture in the River Valley Echos. In addition, the picture depicts the mill pond as being quite large with a tressel bridge constructed diagonally across the pond. The picture also shows two bridges crossing the Root River. The purpose of the small bridge is unknown. The outlet structure is depicted as it appears today. Reportedly, the mills were not in service after 1890.

Mid-1890's - The flour mills were destroyed by fire and the village built its first hydro-electric generating plant on the site.

1922 - Original hydro-electric plant was replaced with existing facility.

Unknown - Concrete cap on the canal intake structure was constructed.

Unknown - Gates replaced on canal intake structure.

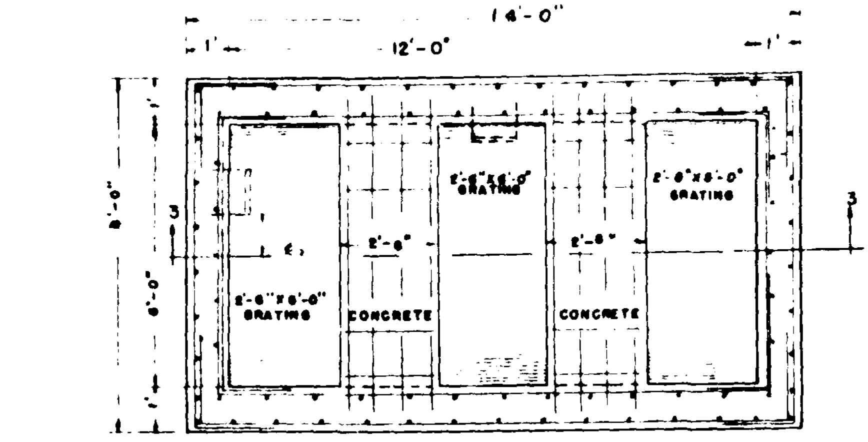
Unknown - Concrete cap on crest was constructed.

1957 - Sanitary sewer crossing of the canal was constructed between powerhouse and dam.

1972 - The deterioration of the downstream or river side face of the canal spillway immediately downstream of the intake structure was repaired by the installation of a concrete wall on the downstream side. The design and construction of this wall was conducted by Griffith Construction Company, Caledonia, Minnesota. The City of Lanesboro applied for a permit to the Minnesota Department of Natural Resources for this construction on November 16, 1972.

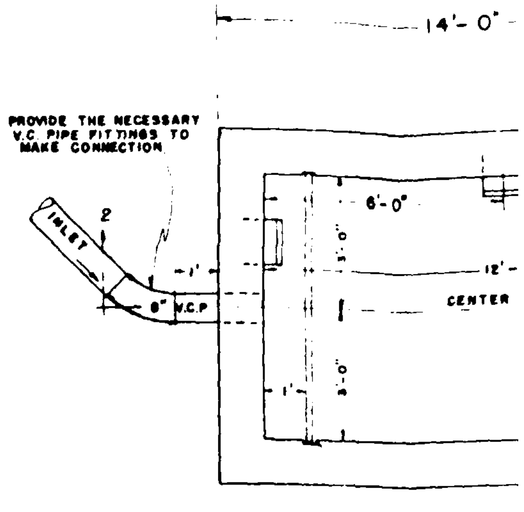
2.2 AVAILABLE DATA

All records and other documented information concerning the design and construction history of the Lanesboro Dam were reportedly destroyed in a fire which occurred in 1941. However, a sanitary storm sewer crossing of the canal was completed in 1957. The design of the sewer was prepared by Associated Consultants, Minneapolis, Minnesota and two plan sheets of this crossing are included as Plates 2-1 and 2-2 of this report. A photograph of the 1972 repair to the canal spillway is enclosed at the end of this section.



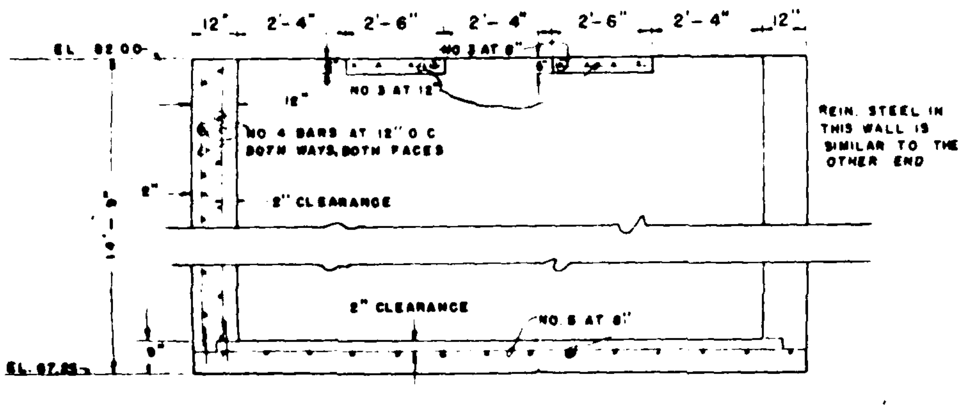
PLAN VIEW SHOWING TOP OF TANK

1/2" = 1'-0"

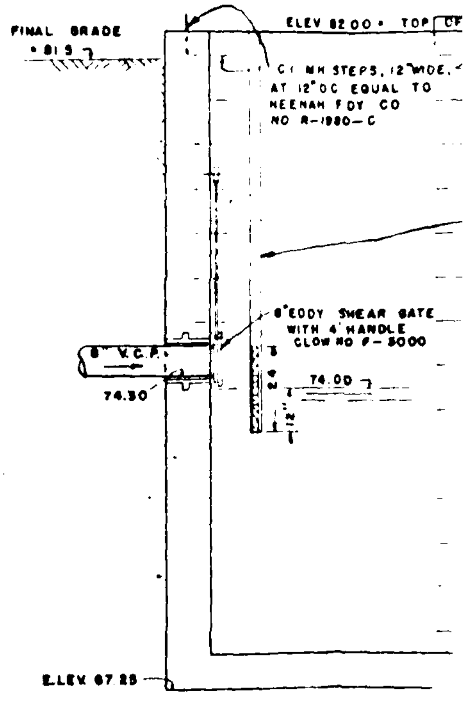


PLAN VIEW BE

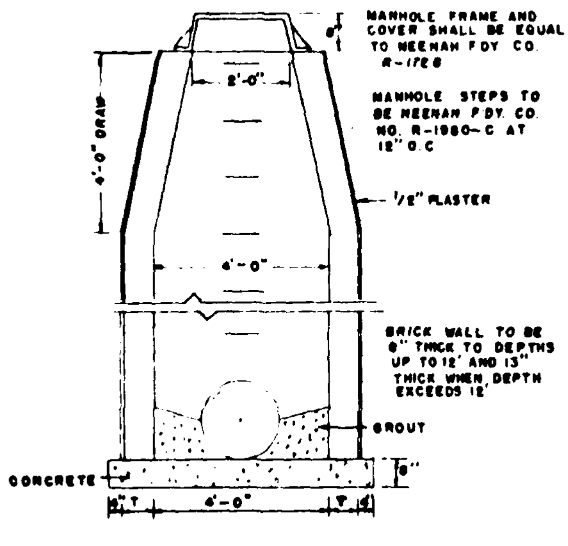
1/2" = 1'-0



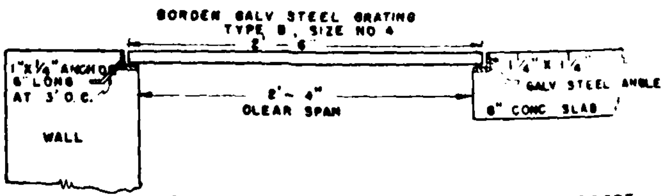
SECTION 3-3



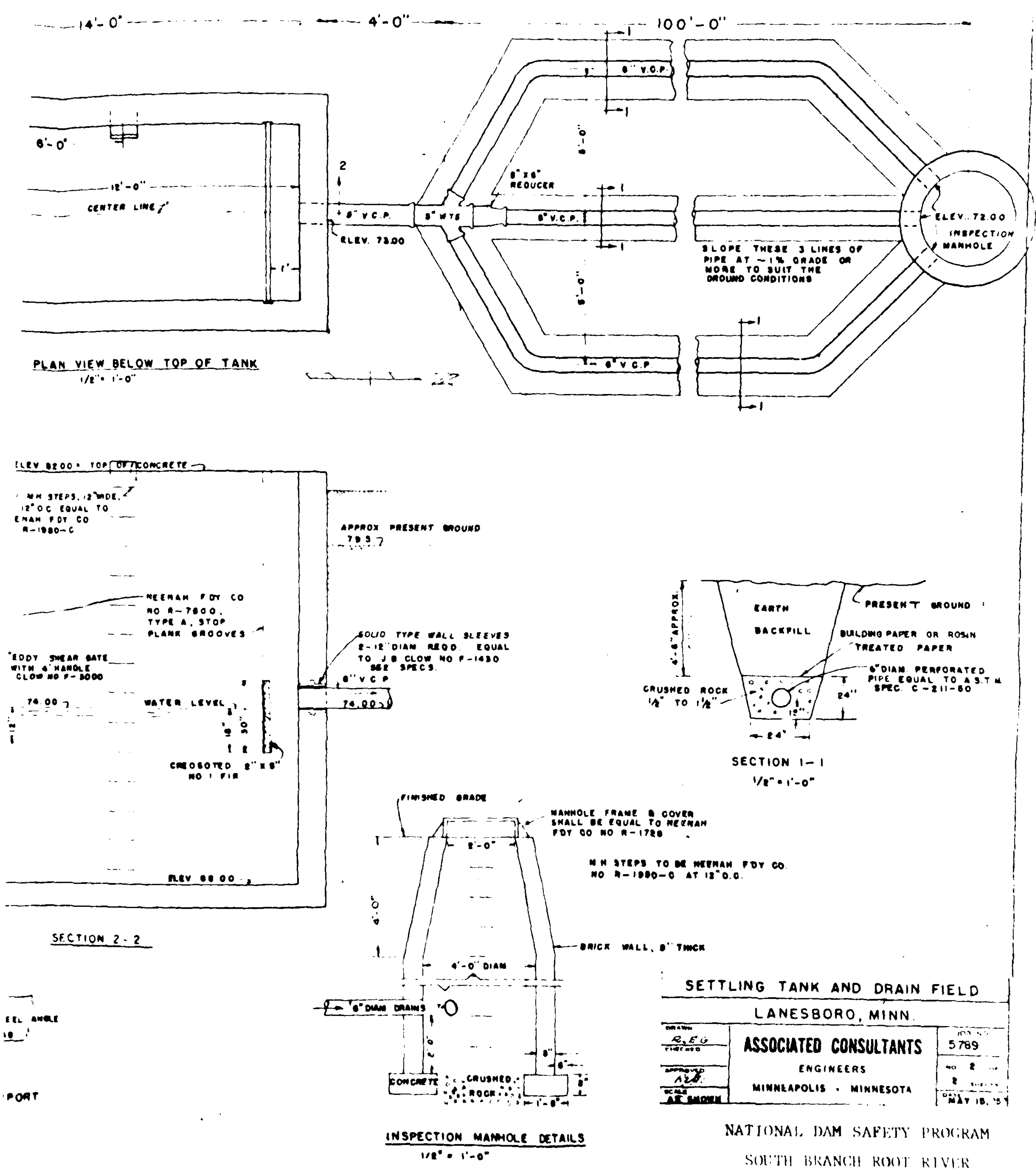
SECTION



STANDARD MANHOLE DETAILS



DETAIL SHOWING STEEL GRATING SUPPORT



NATIONAL DAM SAFETY PROGRAM

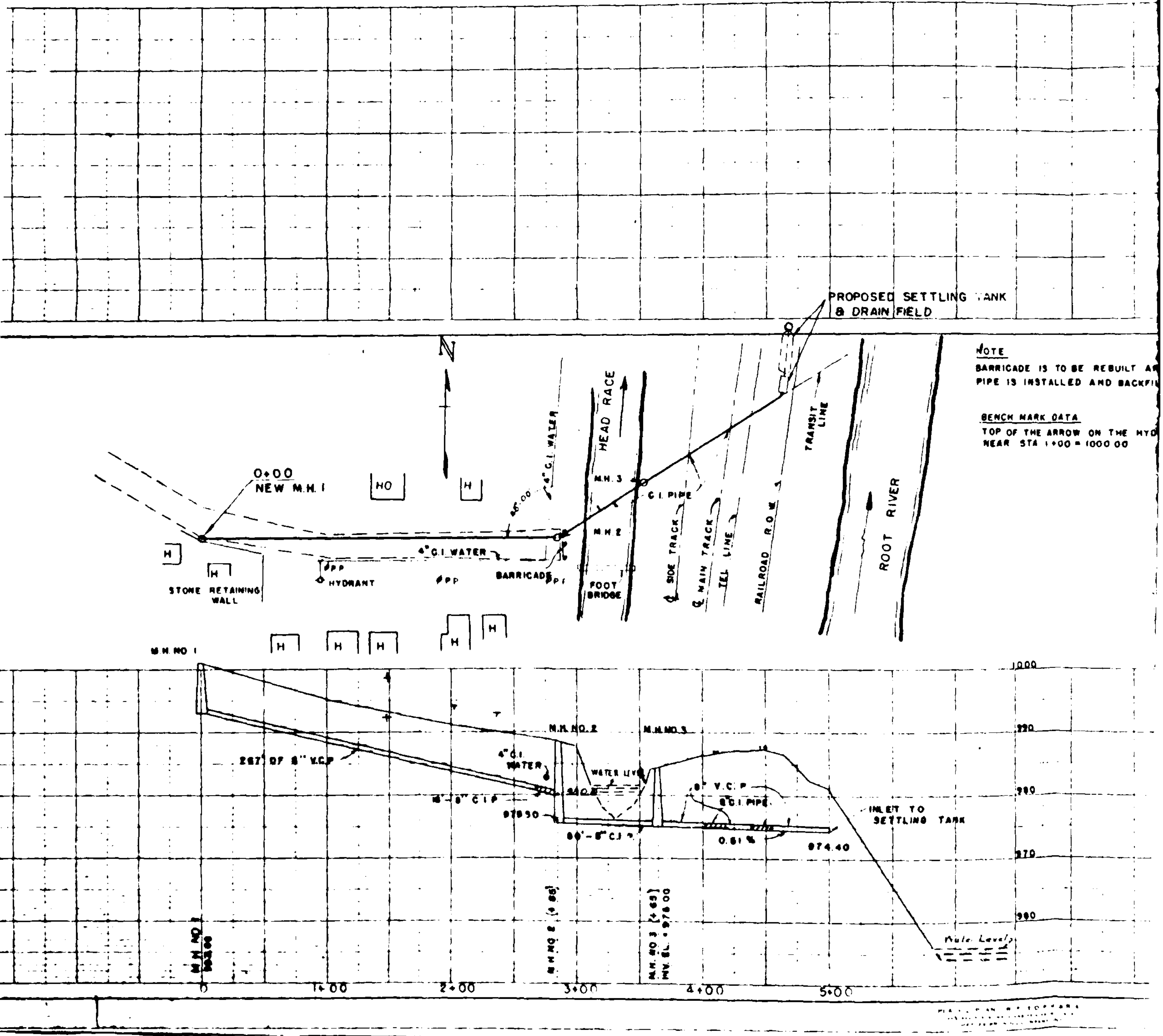
SOUTH BRANCH ROOT RIVER

LANESBORO DAM

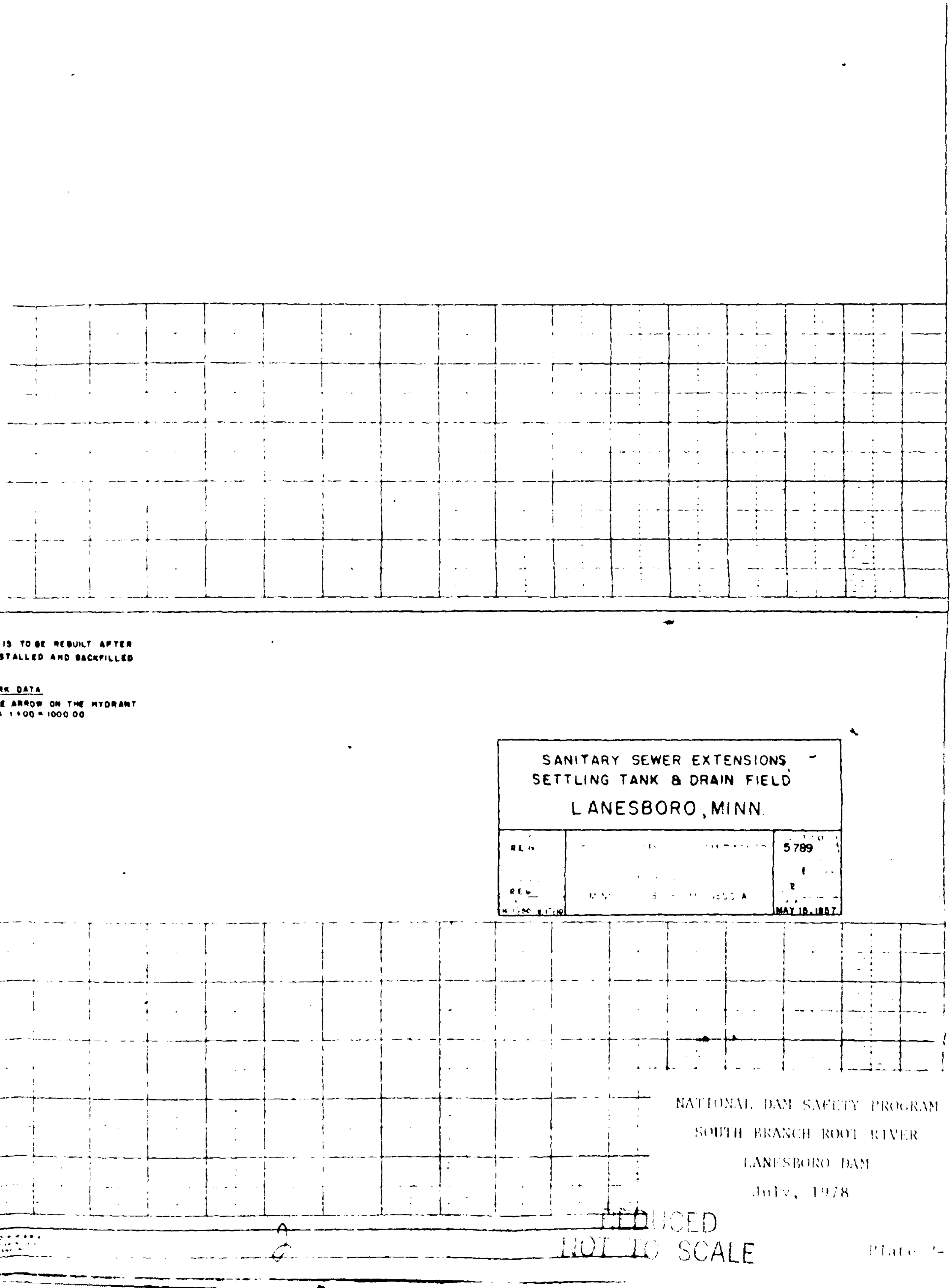
July, 1978

REDUCED
NOT TO SCALE

Plate 2-1



PROPOSED SETTLING TANK
& DRAIN FIELD
NOTE
BARRICADE IS TO BE REBUILT A
PIPE IS INSTALLED AND BACKFI
BENCH MARK DATA
TOP OF THE ARROW ON THE HYD
NEAR STA 1+00 = 1000.00
N
0+00
NEW M.H. 1
HO
H
4" C.I. WATER
HEAD RACE
M.H. 3
C.I. PIPE
M.H. 2
4" C.I. WATER
BARRICADE
HYDRANT
STONE RETAINING WALL
FOOT BRIDGE
SIDE TRACK
MAIN TRACK
TEL. LINE
RAILROAD R.O.W.
TRANSIT LINE
ROOT RIVER
M.H. NO. 1
M.H. NO. 2
M.H. NO. 3
287' OF 8" V.C.P.
4" C.I. WATER
WATER LEVEL
8" V.C.P.
8" C.I. PIPE
INLET TO SETTLING TANK
979.50
0.61 %
974.40
1000
990
980
970
960
0
1+00
2+00
3+00
4+00
5+00



NATIONAL DAM SAFETY PROGRAM
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
July, 1978

REDUCED
NOT TO SCALE

Plate

REPAIR PHOTOGRAPH

SECTION 3
HYDRAULIC AND HYDROLOGIC EVALUATION

3.1 AVAILABLE DESIGN DATA AND RECORDS

a. The Federal Insurance Administration, Department of Housing and Urban Development, has prepared a FIA flood hazard boundary map for the City of Lanesboro. The map, dated 4 June 1978, provides information on areas of probable flooding within the corporate limits of Lanesboro.

b. A brief discussion of the Root River watershed unit is presented in the Minnesota Department of Conservation, "Hydrologic Atlas of Minnesota", Bulletin 10, April, 1959. This discussion includes such items as basin topography, climatology, stream flow characteristics, ground water and water supply.

c. Surface areas of the main stream lakes where dams act as outlet controls are found in the Minnesota Department of Conservation, "Inventory of Minnesota Lakes", Bulletin 25, 1968.

d. U.S. Geological Survey stream flow records are not available at the dam site in Lanesboro. The nearest stream flow gaging station is located on the Main Branch of the Root River 1.4 miles upstream of the confluence with the South Branch of the Root River. The dam is located on the South Branch of the Root River 2.8 miles upstream of its confluence with the Main Branch of the Root River. The U.S.G.S. gage near Lanesboro has a drainage area of 615 square miles. Datum on the gage is 791.32 feet M.S.L., 1929 adjustment. Records are available for the years 1911 through 1914, 1915 through 1917, and 1946 to the present. The annual instantaneous peak discharges for the gage near Lanesboro are presented in Table 3-1. Discharges for various recurrence intervals on the South Branch of the Root River were determined for the Lanesboro Dam by the Corps of Engineers, and are presented as Plate 3-1. Plate 3-2 is the discharge frequency curve for the mean daily discharge rates as developed by the Corps of Engineers.

e. U.S. Geological Survey quadrangles were used to determine the drainage area upstream from the dam. These quadrangles were also used to determine the stage-storage curve which is presented as Plate 3-3 of this report. Plate 3-4 is the stage-surface area curve developed for the pool. Sections obtained from the U.S.G.S. quadrangles were used to develop headwater and tailwater curves. These curves are presented as Plates 3-5 and 3-6 of this report.

3.2 RUNOFF CHARACTERISTICS AND MAJOR FLOODS

a. The Root River generally reaches its highest discharge peaks of the year in March or April. These runoff events are caused by snowmelt or a combination of snowmelt and rainfall. However, for the period of record, many of the annual peaks have occurred in June or July following intense storms. One peak occurred in late September and was the result of an intense storm of relatively short duration. The river basin has streams with a very well integrated drainage system in a deeply incised stream valley. This tends to cause rapid response to precipitation and produces high flows with short durations. This results in short duration floods within the river basin. There are no large lakes or ponding areas to provide flood storage or lagging of the peaks along the river basin. The average discharge for the Root River near Lanesboro for the 41 years of record is 333 cfs at the U.S.G.S. gaging station. This corresponds to an average of 7.40 inches of runoff per year over the watershed. The adjusted average annual discharge for the South Branch of the Root River at the Lanesboro Dam is 150 cfs.

b. The largest flood of record in the Upper Root River Basin occurred in March, 1962. This was the result of a very rapid warming trend which occurred during March 25 through 28, accompanied by continuous day and night winds that contributed to the rapid spring thaw in the area. The instantaneous peak discharge of 22,100 cfs was reported on March 29 at the gage near Lanesboro. This corresponds to a recurrence interval of 8 percent. From the drainage area relationship, the discharge at the Lanesboro Dam was estimated to be 14,300 cfs.

No damage to the Lanesboro Dam was reported to have resulted from this flood event.

3.3 HYDRAULIC ASPECTS OF OPERATION PROCEDURES

There is no documented operating plan for the Lanesboro Dam. The Lanesboro Dam is operated primarily for the production of hydro-electric power. The intake structure, located near the dam, is a gravity structure which contains three vertical slide gates set in timber slides on the upstream face. The intake gate to the powerhouse at the downstream end of the canal is inoperable at this time. Water is transported from the canal via a penstock to the turbines where the flow is controlled by the wicket gates in the turbine. After passing through the turbine, the water is transmitted to the river through a second conduit or draft tube. The normal operation of the small turbine is currently between the hours of approximately 8 a.m. and 4 p.m. when personnel are present at the plant.

3.4 CONSEQUENCES OF SUDDEN BREACHING BY OVERTOPPING OR STRUCTURAL FAILURE

The consequences of a failure of the Lanesboro Dam were analyzed for five combinations of flow conditions and modes of failure. The downstream impacts of a sudden failure of the dam are highly dependent upon the mode of failure. Specific cases are described below:

- Failure of the primary spillway under normal operation and flow conditions with a pool elevation of 847.0±.

- Failure of the canal embankment under normal operation and flow conditions with a pool elevation of 849.5±.

- Failure of the spillway under high flow conditions prior to overtopping of the canal intake structure at elevation 855.6±.

- Failure or partial failure of the canal embankment due to overtopping at elevation 855.6±.

* Failure of the primary spillway above elevation 855.6± and approaching the level of the Probable Maximum Flood.

a. Case 1 evaluates the effects of a structural failure of the primary spillway at a normal pool elevation of 847.0± and a tailwater near elevation 822.0±. For this case it was estimated that a maximum initial flood wave of 11 feet would propagate immediately below the dam. The flood wave could overtop the bank of the river beyond the County Highway 250 bridge through Lanesboro. The broad floodplain immediately downstream of the dam would decrease the height of the wave, but a flooding condition would still exist. There is a high probability of more than a few deaths from a failure of this type. The magnitude of possible damage which could occur downstream is also great. Damage probably would occur to the C.M.St.P. & P.R.R. bridge, C.S.A.H. 8 bridge, numerous residences, and the County Highway 250 bridge.

b. Case 2 evaluates the effect of a failure of the canal earth embankment at a normal pool elevation of 849.5± and a tailwater near elevation 825.5±. The discharge for this condition is 2600 cfs. A failure at this pool elevation could be caused by flow over the canal embankment with the gates in the headrace intake structure open. Initially, erosion would begin slowly but gradually become more rapid, leading to a complete breach of the embankment. However, the resulting flood wave would probably be relatively small. One reason for the small flood wave is that the direction of flow through the breach would be perpendicular to the flow axis of the river. Flow through the breach would be directed across the floodplain and a substantial amount of energy would be required to divert the flow down the river channel. The discharge capacity of the channel is also limited by the discharge capacity of the intake structure. This means that once the water in the canal has been discharged, the flow would be controlled by the intake structure. Flow into the canal could, at any time during this type of failure, probably be stopped by closing the gates in the intake structure. It is estimated that only a random chance for loss of life would occur during a failure of this type and property damage would be held to a minimum.

c. Case 3 is a failure of the primary spillway under high flow conditions just prior to overtopping at elevation 855.6±. The tailwater elevation is estimated to be near 836.8±. The probability of recurrence of a flood reaching elevation 855.6± is 6 percent, with a corresponding discharge of 16,700 cfs. In this case, the initial maximum flood wave resulting from a complete failure of the dam is estimated to be approximately 8 feet immediately downstream of the dam. This flood wave would probably cause some damage to the downstream bridges and to many residential dwellings in the floodplain downstream. The chance of loss of life is estimated to be only probable because the flood waters would have likely caused evacuation of the downstream dwellings prior to failure of the dam.

d. Case 4 evaluates the failure or partial failure of the canal embankment due to overtopping of the dam at elevation 855.6±. Up to elevation 855.6±, the flow in the canal can be controlled by the gates in the canal intake structure. However, above this elevation, the canal intake structure would be overtopped and the flow in the canal would be controlled only by the headwater in the channel. As water flows over the top of the intake structure, initial flow would be over the canal spillway, but as the headwater elevation increases, the earth embankment of the canal would be overtopped and breached. Failure by this mode would be similar to that in Case 2, except that the discharge cannot be controlled. The breach in the canal is not expected to be much larger than the cross-sectional area of the canal. The failure of the canal embankment is not expected to significantly increase either the extent of property damage or possibility of loss of life.

e. In order to develop the mechanics of the failure that might occur at reservoir levels higher than 855.6±, the Probable Maximum Flood was evaluated. The Probable Maximum Flood peak discharge for the Lanesboro Dam site is approximately 120,000 cfs. This is about seven times the discharge capacity of the Lanesboro Dam. Assuming that all structural components of the Lanesboro Dam are still intact, the flow will be restricted across the crest of the dam because of

the sharp vertical bedrock outcrops. It is also anticipated that flow will be short-circuited through the town to the southeast between the right abutment and Highway 250 as the headwater approaches elevation 860±. A failure of the dam at this time could be possibly beneficial in that a larger proportion of the flow would be carried by the main channel, which could decrease the extent of damage sustained by the southern portion of town. It is thought that a failure during the Probable Maximum Flood would not significantly increase the hazard to either downstream property or life.

3.5 RELATIONSHIP BETWEEN STRUCTURE AND OTHER DAMS ON THE SAME WATERCOURSE

There are no known downstream dams on the Root River between Lanesboro and its confluence with the Mississippi River. There no known dams upstream of Lanesboro on the Root River. The only dam along the main stem of the Root River is in Section 35, T104N, R10W, 4-1/2 miles upstream of the U.S.G.S. gage. Under all flood conditions, a failure of the Lanesboro Dam would probably have no significant effect upon the structure.

3.6 SUPPORTING DATA

a. Discharge frequency curves were derived for the Lanesboro Dam. These curves were developed from the relationship of the discharge frequency curves for Preston, as furnished by the Corps of Engineers. These discharge frequency curves are shown as Plates 3-1 and 3-2 in this report.

b. Stage-volume and stage-surface area capacity curves were derived from U.S.G.S. quadrangle maps. The volume below the existing water surface elevation was estimated. The stage-volume curve and stage-surface curve are presented as Plates 3-3 and B-9 of this report respectively.

c. The headwater rating curve, as shown in Plate 3-5, was derived based on information obtained in the field.

d. A tailwater rating curve, presented as Plate 3-6, was developed for various discharges by applying Manning's equation to typical cross-sectional areas of the channel downstream of the dam near the Highway 250 bridge crossing.

e. A synthetic Probable Maximum Flood hydrograph for the South Branch of the Root River at Lanesboro is shown as Plate 3-7.

3.7 SUMMARY

a. The Lanesboro Dam does not meet accepted dam safety criteria because it is not capable of passing the Probable Maximum Flood (120,000 cfs) without overtopping. The overtopping discharge of 16,700 cfs is 14 percent of the Probable Maximum Flood. The 1 percent recurrence frequency flood of 30,000 cfs cannot be passed without overtopping the dam.

The currently accepted dam safety criteria indicate that because the Lanesboro Dam is within the "intermediate" size and "high" hazard classifications, the structure should be designed to have the ability to pass the Probable Maximum Flood without failure. However, because it is believed that the hazard to downstream life and property is greatest during normal flow and moderately severe flood conditions, the hazard becomes less significant at flood levels approaching the Probable Maximum Flood. No recommendation is made regarding modification of the facility to provide for passage of the PMF without failure. It is recommended that a spillway design flood be determined on the basis of more detailed evaluations of the hydrologic, hydraulics and downstream damage potential to the dam and appurtenant structures and that such modifications, as are required to allow safe passage of the design flood be implemented.

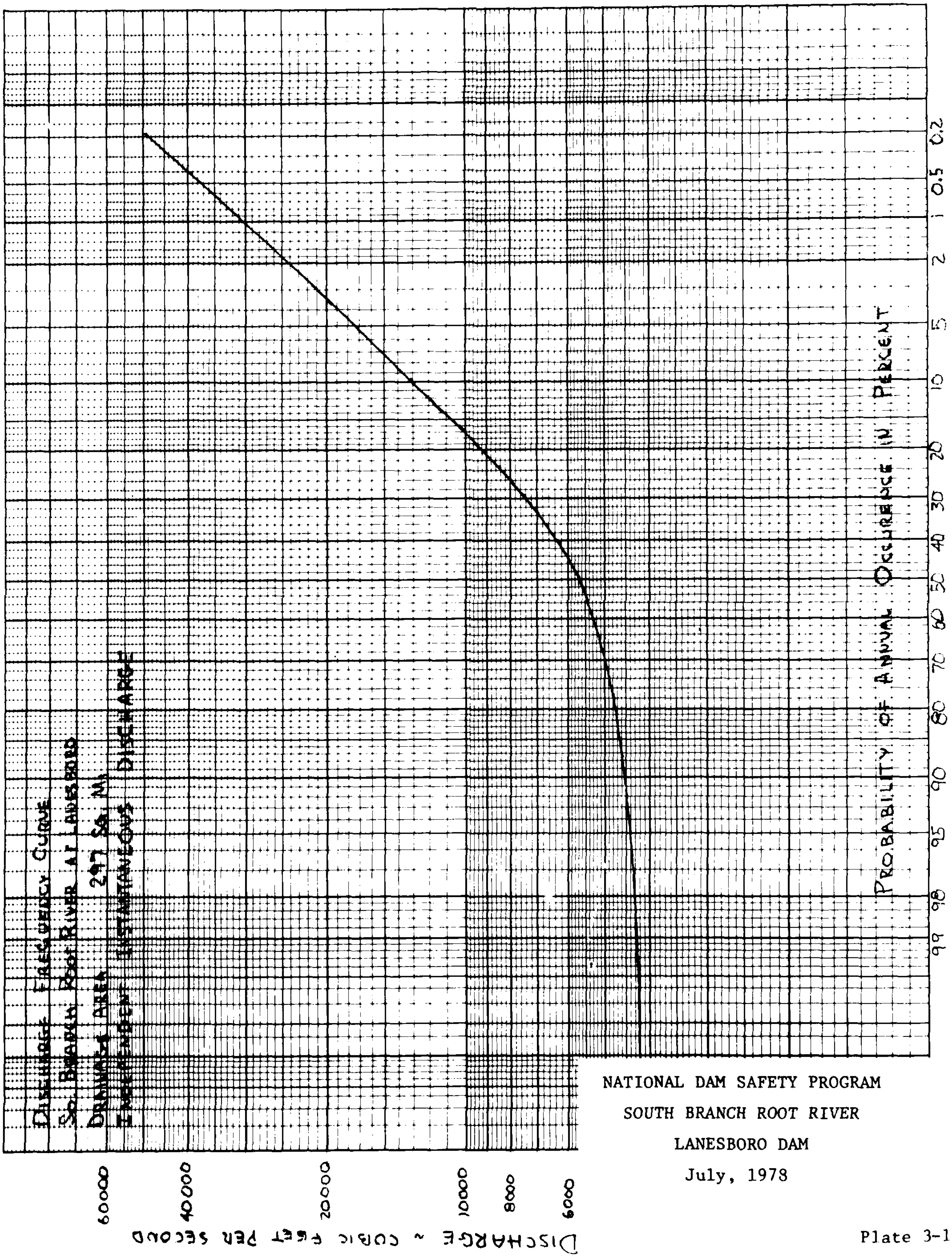
b. The greatest hazard to the downstream area is presented by failure of the spillway during normal pool elevation of 847.0±. Significant loss of life and property damage could occur as a result of a failure of this type. The next greatest hazard is presented by the failure of the primary spillway during flood conditions. Failure of the canal earth embankment during all flow conditions probably would not significantly increase the hazard to the downstream populous. Although failure of the dam during the Probable Maximum Flood would not significantly increase the amount of downstream damage or loss of life, it could possibly reduce the amount of flooding in the City of Lanesboro during this type of event. It is recommended that a documented plan be developed for

closing the various bridges during major floods and warning the populous of the hazardous conditions which will exist near the river during flood conditions .

c. It is recommended that a documented hydraulic operation plan be developed and implemented. Also, it is recommended that the intake gate to the powerhouse at the downstream end of the canal be repaired.

TABLE 3-1
SOUTH BRANCH ROOT RIVER AT LANESBORO
U.S.G.S. GAGE NEAR LANESBORO ON MIDDLE BRANCH ROOT RIVER
ANNUAL INSTANTANEOUS PEAK DISCHARGES

Year	Date	Peak Discharge (cfs)
1976	12 MAR	14,100
1975	29 APR	7,340
1974	21 JUN	17,500
1973	12 MAR	11,400
1972	29 SEP	8,260
1971	1 APR	7,650
1970	29 MAY	2,430
1969	4 APR	7,340
1968	23 JUN	1,790
1967	26 MAR	12,200
1966	9 FEB	16,200
1965	1 MAR	19,000
1964	29 JUL	409
1963	23 MAR	7,250
1962	29 MAR	22,100
1961	26 MAR	19,500
1960	3 JUL	8,100
1959	26 JUN	9,170
1958	5 JUN	17,800
1957	21 JUL	4,530
1956	2 APR	5,430
1955	10 MAR	4,090
1954	19 JUN	4,090
1953	27 JUL	8,370
1952	31 MAR	20,400
1951	21 JUL	16,400
1950	27 MAR	20,500
1949	1 APR	6,470
1948	28 FEB	7,220
1947	5 APR	7,620
1946	5 JAN	10,400
1945	16 MAR	13,900
1944	18 JUN	5,570
1943	25 MAR	8,490
1942	29 JUN	15,000
1941	18 APR	5,460
1940	11 JUL	5,070
1917	23 MAR	12,000
1916	13 MAR	5,020
1915	--	--
1914	27 JUN	9,670
1913	14 MAR	11,800
1912	29 MAR	7,930
1911	13 AUG	13,300
1910	9 MAR	2,040

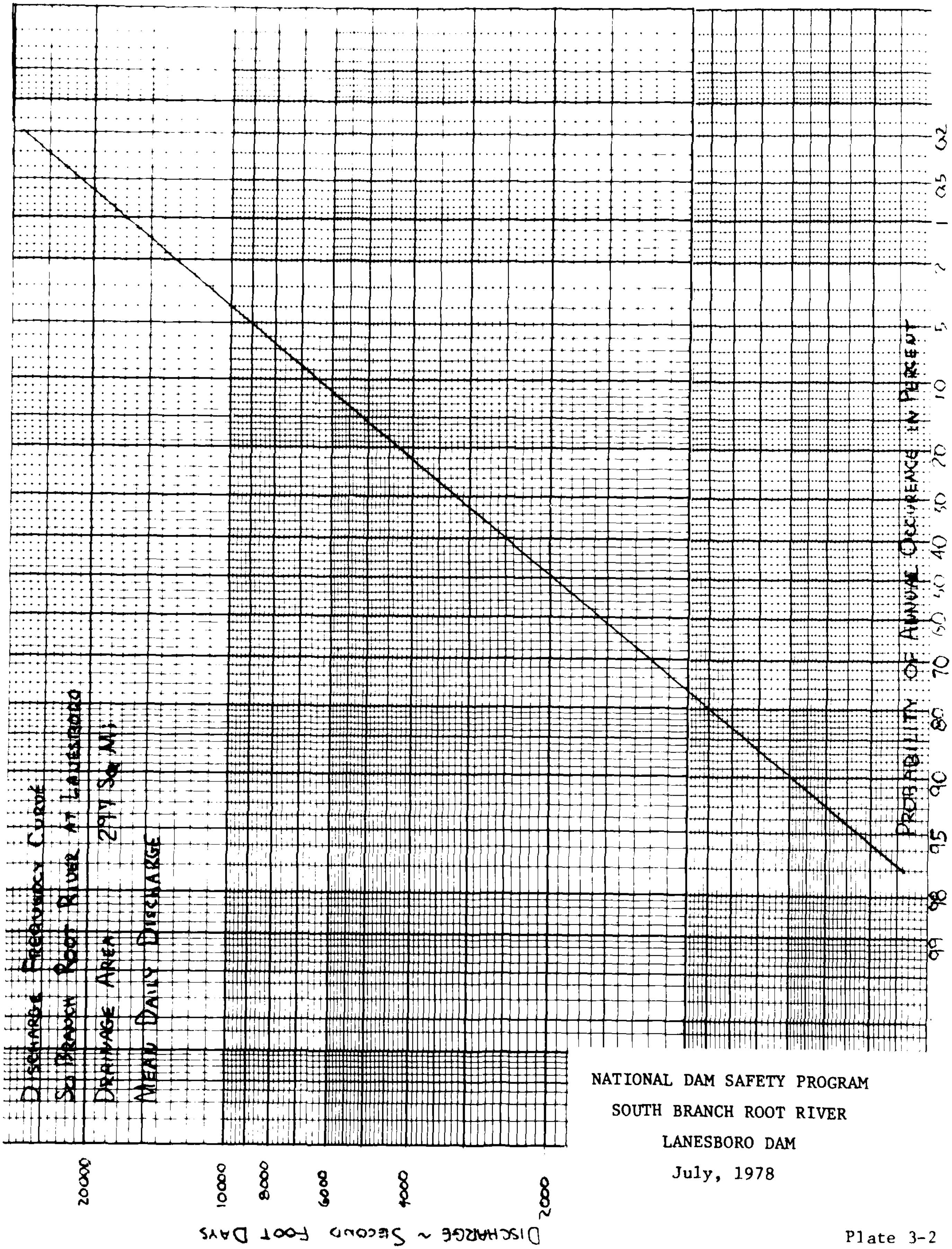


NATIONAL DAM SAFETY PROGRAM

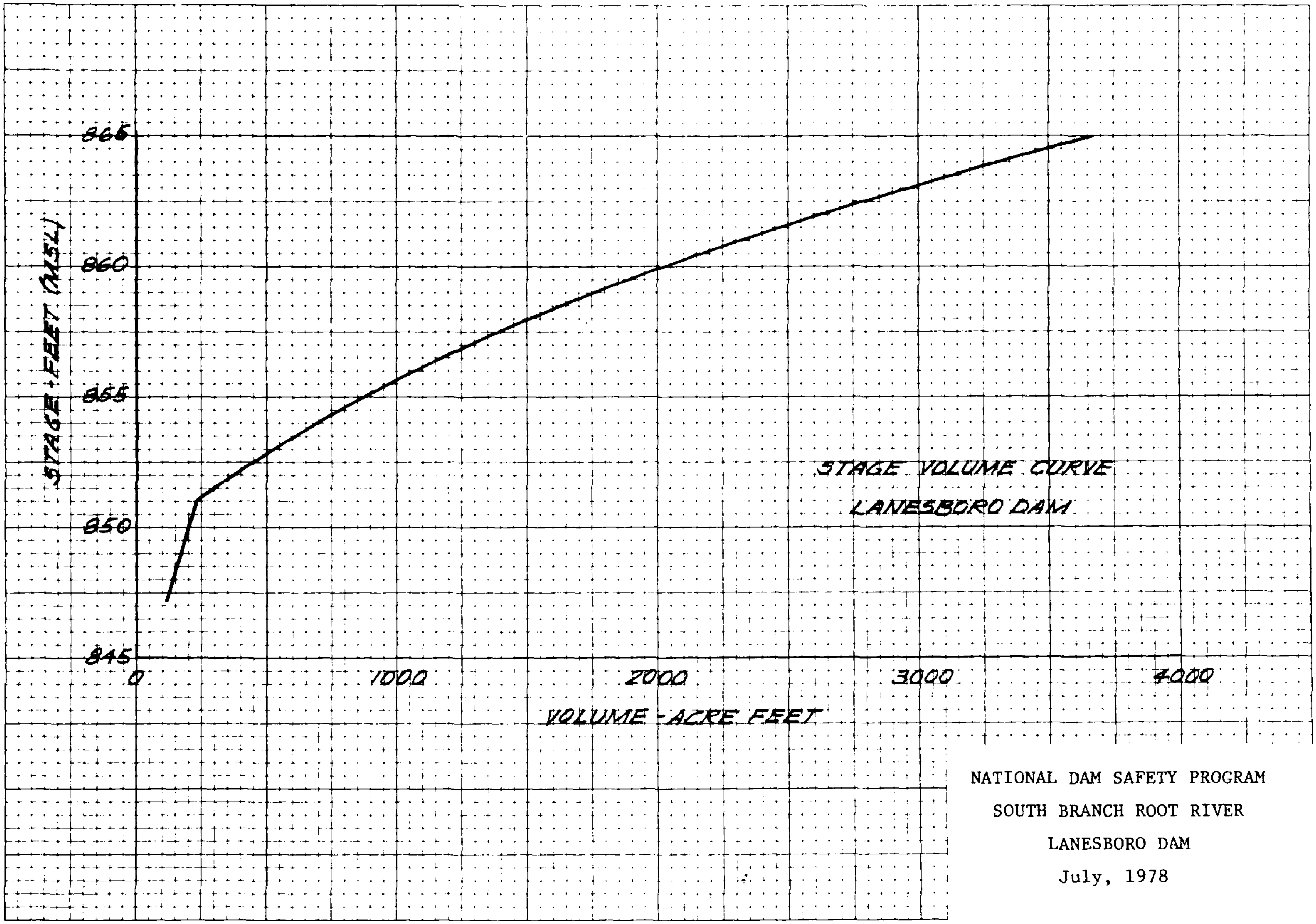
SOUTH BRANCH ROOT RIVER

LANESBORO DAM

July, 1978



NATIONAL DAM SAFETY PROGRAM
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
July, 1978



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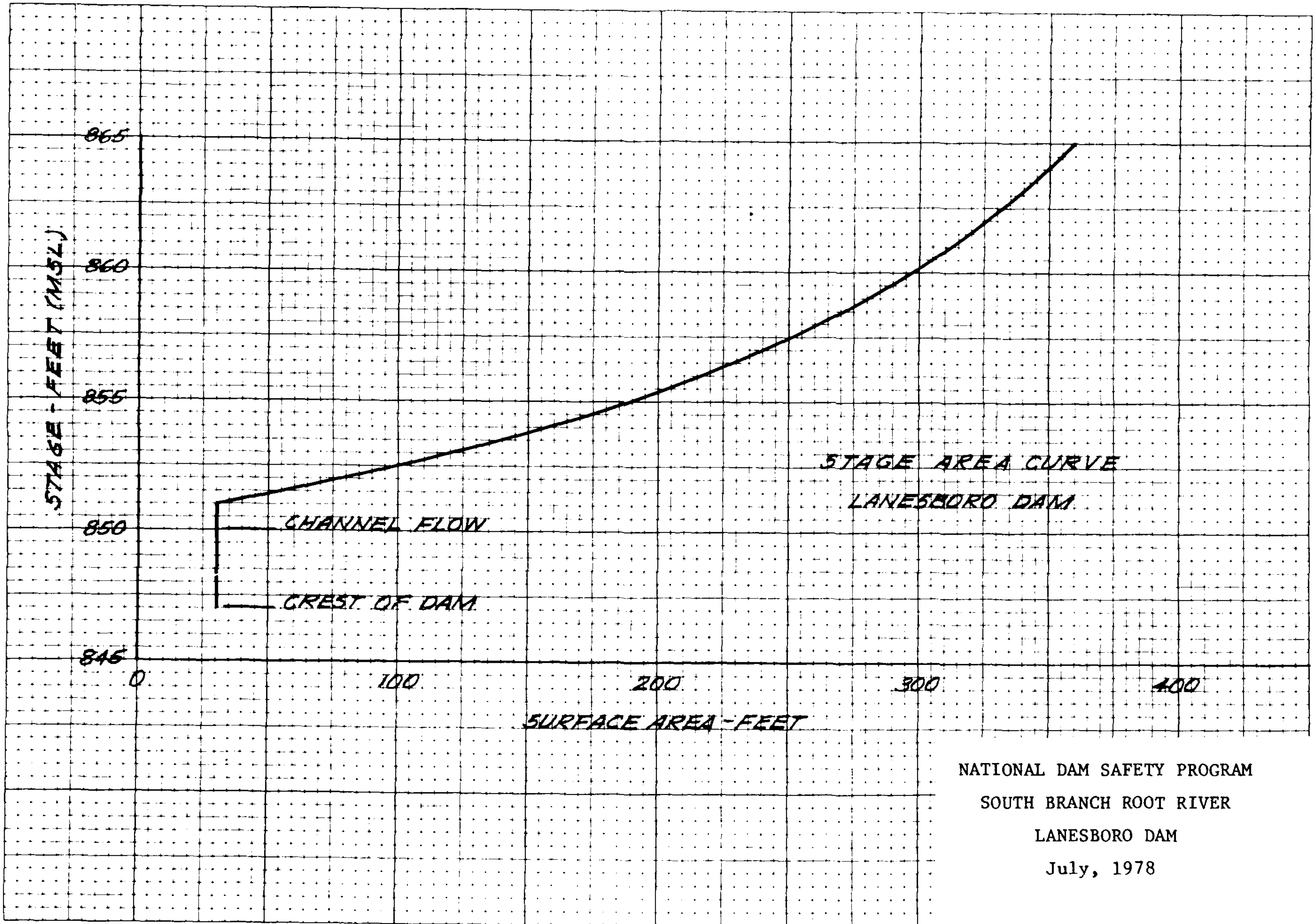
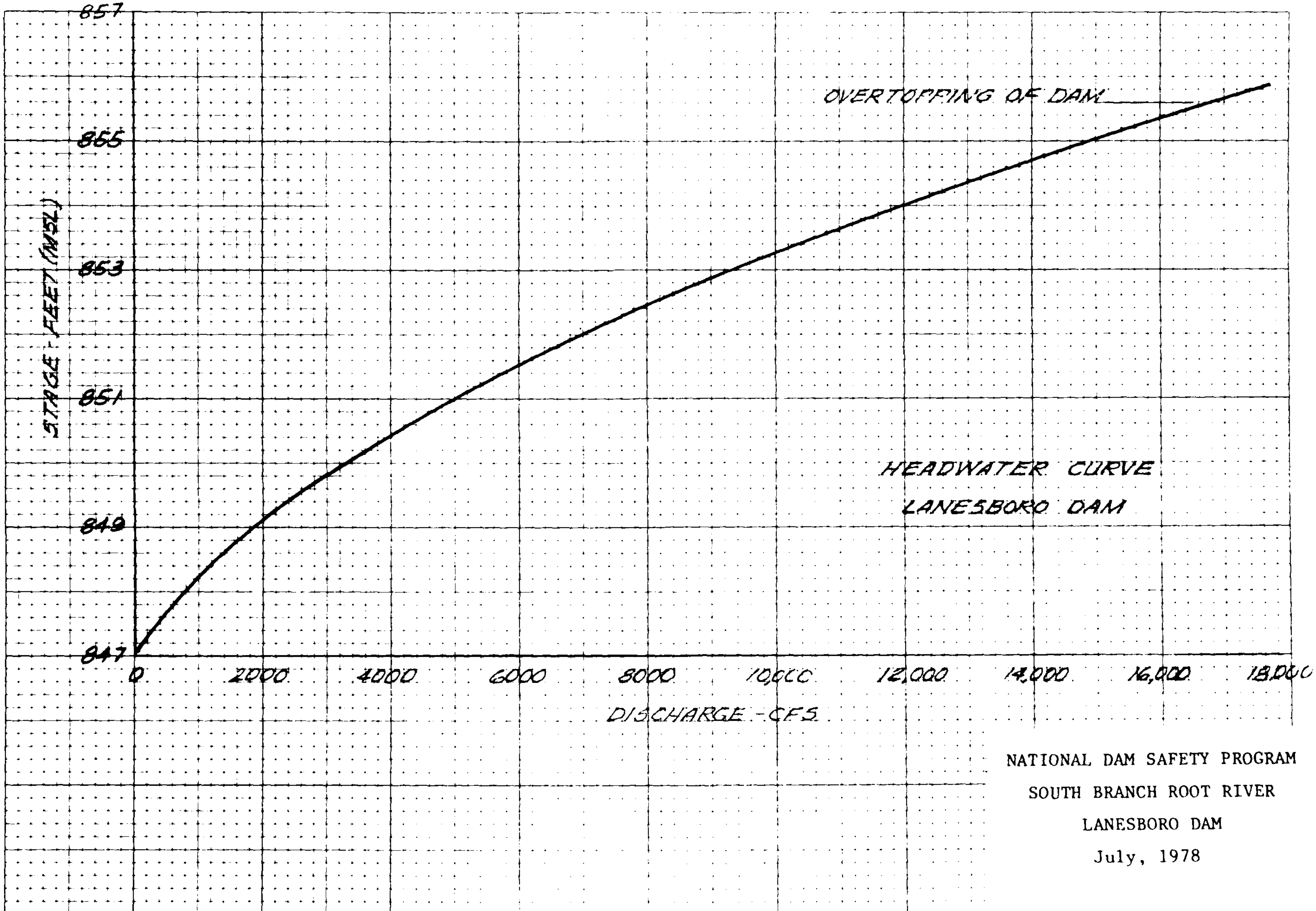
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
July, 1978



NATIONAL DAM SAFETY PROGRAM
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
July, 1978

Plate 3-4



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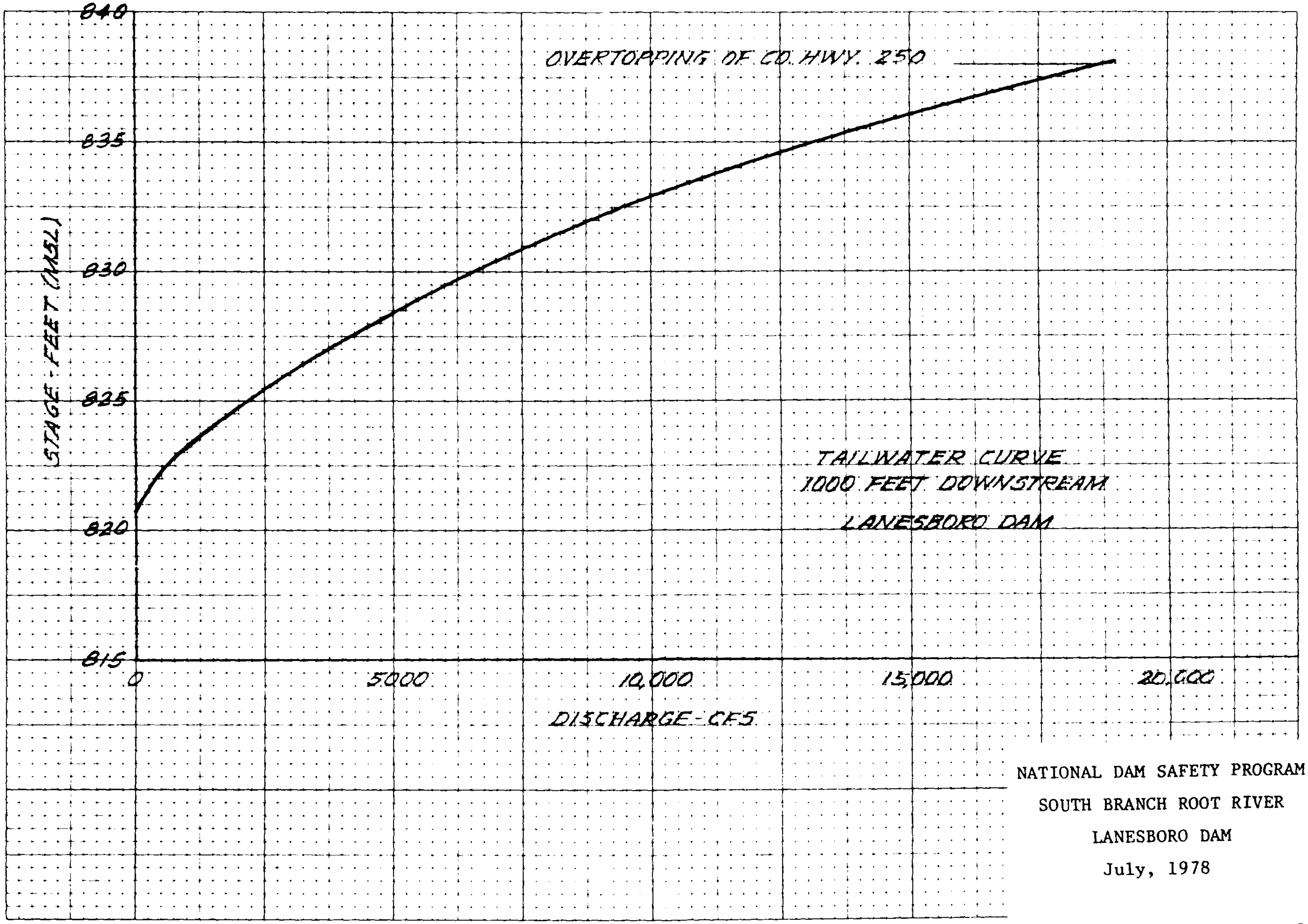
SOUTH BRANCH ROOT RIVER

LANESBORO DAM

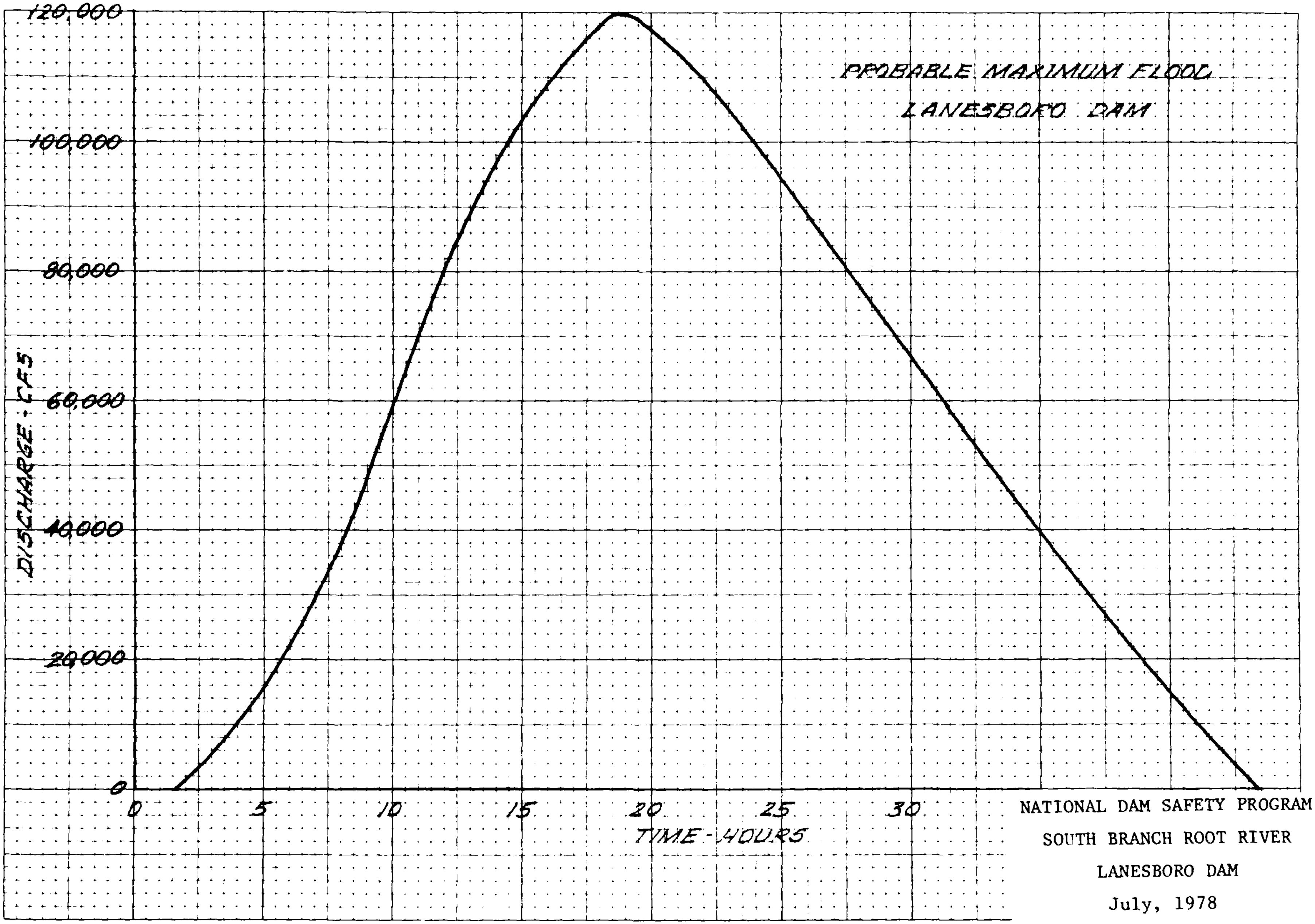
July, 1978

Plate 3-5



NATIONAL DAM SAFETY PROGRAM
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
July, 1978

Plate 3-6



NATIONAL DAM SAFETY PROGRAM
SOUTH BRANCH ROOT RIVER
LANESBORO DAM
July, 1978

SECTION 4
EVALUATION OF PHYSICAL ASPECTS
OPERATION AND MAINTENANCE

4.1 RESPONSIBILITY

The City of Lanesboro is the owner and has the responsibility for operation of the Lanesboro Dam. When engineering is required, the City Council hires a consulting firm.

4.2 OPERATION

This section deals with the ability of the structural and mechanical components of the dam to function as originally intended. The hydraulic implications of the operating procedures are discussed in Section 3 of this report. Under normal conditions, the head gates of the canal intake structure are left in the open position. The turbine is controlled by operating the wicket gates. However, as a result of the field inspection, the head gates were ordered closed because severe seepage and piping through the canal embankment near the abutment of the canal spillway was noted. The gate on the intake structure to the penstock is not operable at the present time.

4.3 MAINTENANCE

At this time, there is no formal documented maintenance program for the Lanesboro Dam. Maintenance of the electrical equipment and instruments, as well as the mechanical equipment, is carried out by Mr. Lloyd Smith, Superintendent of Public Works.

4.4 INSPECTION

An on-going maintenance program is essential to the integrity of a water retaining structure such as the Lanesboro Dam. The basis for such a maintenance program should consist of an informal and formal program of inspection. The informal program is often the most important and requires normal operating personnel who are conscious of the normal day-to-day

condition of the structure and of specific features which have been identified as potential problems. This procedure would allow any changes in site conditions to be noted and evaluated in a timely manner. The formal aspect of a continuing inspection program should consist of a regularly scheduled systematic inspection of all the features of the structure. Such inspections usually involve formal documentation and in some cases photographs of the structure. Such an inspection provides a frame of reference for evaluating future changes in the condition of the structure. The recommended frequency for formal inspections is annually and during or after every instance of unusually high water or high wave conditions. A comprehensive inspection program currently does not exist for the Lanesboro Dam.

4.5 SUMMARY

At present, the dam is visited by operating personnel on a non-routine basis. In view of the potential consequences involved in overtopping of the embankments, a more frequent visitation schedule may be desirable, but such a schedule should be related to the development of an overall operating plan, as described in Section 3. Historically, very little maintenance has been required. It is recommended that a formal inspection program should be implemented to detect deficiencies related to seepage, scour and structural distress. It is also recommended that an operation and maintenance manual be developed to insure the structure continues to function as originally intended. Also, it is reccmmended that a formal documented operating plan be developed.

SECTION 5
GEOTECHNICAL EVALUATION

5.1 AVAILABLE SUBSURFACE INFORMATION

Subsurface information at Lanesboro was obtained from published documents and papers. Shallow hand auger borings and visual observation by Barr Engineering Co. during the current field inspection were performed to verify the subsurface geologic data.

5.2 GENERAL GEOLOGY

The land surface features of the Root River basin near Lanesboro is a plateau divided by deeply incised bedrock valleys. In the harder rocks, the valleys are narrow and canyon-like, but those in the softer rocks reach a width of 1 mile in places and contain extensive deposits of alluvium. The streams generally flow in rapids where they cross the harder to softer rocks. Changes in the hardness of the rock is also marked by terraces along the sides of the valleys. The terraces of the Root River valley consist of stratified sand and gravel. The plateau along the Root River is reportedly loess with scattered patches of glacial drift. The loess is a fine yellow loamy silt with a thickness of generally less than 10 feet. The glacial drift is very thin, where present, and is a clay mixed with pebbles and boulders. The drift is reportedly a Kansan or older.

Upstream of Lanesboro, the Galena limestone, the Decorah shale, Platville limestone and the St. Peter sandstone outcrop in a number of bluffs bordering the Root River. At Lanesboro, the Prairie-du-Chien group is present, which consists of Shakopee dolomite, the New Richmond sandstone and the Oneota dolomite. The bedrock at Lanesboro is believed to belong to the Oneota formation. The Prairie-du-Chien group is directly above the Jordan sandstone and reportedly is hydraulically connected. The Jordan sandstone reportedly outcrops near Lanesboro.

It is reported that where the soils are underlain by the very soluble Galena limestone, there are many sink holes and depressions. In the

area near Lanesboro, there are many large springs. These springs are reportedly issuing from the New Richmond sandstone and possibly from the Oneota dolomite and Jordan sandstone. The presence of these springs indicate that large streams flow through the deep lain Paleozoic rocks. The drainage of the region is reportedly sufficient to produce sufficient underground erosion to carve long caverneous passages out of the limestone.

5.3 SITE GEOLOGY

Plates 1-4, 1-5, and 1-6 indicate the stratiography at the Lanesboro Dam. The Root River valley at Lanesboro is approximately 150 to 250 feet below the surrounding plateau. The Root River has cut into the limestone (dolomite) bedrock and outcroppings were noted on both sides of the dam. Large springs reportedly occur about 1-1/2 miles upstream of the dam and 1/4 mile downstream of the dam. Sand pits also occur downstream, however, none were noted upstream of the dam.

The dolomitic limestone is jointed and horizontally bedded near the Lanesboro Dam. The limestones, which include the dolomite, are easily soluble rocks and solution channels may develop along joints, bedding planes, or other fractures. Reportedly, cavernous conditions may exist near Lanesboro, however, no sink hole topography was noted. The limestone is generally well cemented and appears to be structurally adequate. The limestone at the Lanesboro Dam is subject to scouring.

5.4 EXISTING STRUCTURE

The Lanesboro Dam was constructed in 1868. The railroad between Austin and LaCresent, Minnesota was also constructed through Lanesboro adjacent to the spillway during the same year. Old pictures of Lanesboro indicate that a canal and mill pond were constructed to the left of the spillway. Mills were constructed along the canal and apparently the earth embankments along the canal were utilized as a railroad grade. The mills no longer exist, however, the canal is still used to provide water for a small hydro-electric plant. The primary dam, canal, appurtenances, and powerhouse are described in the following paragraphs.

a. Primary Spillway

The primary spillway consists of an overflow and non-overflow sections. The primary spillway is an uncontrolled arch shaped overflow and is depicted graphically in Plates 1-2, 1-3, and 1-4. The primary spillway is constructed of stone with "cramps" and on mortar. The "cramps" are reportedly cables strung vertically through the rock in the dam. The length of the overflow spillway along the arch and the non-overflow sectic are approximately 193 feet and 50 feet, respectively. The radius of the arch is approximately 190 feet. Due to the river flow during the field inspection, the structural height of the overflow spillway could not be determined conclusively, but exceeds 22 feet. The height of the non-overflow section is approximately 13 feet. The crest of the overflow section of the spillway is reportedly reinforced concrete. The spillway is founded on bedrock and is abutted on both the right and left by limestone outcrops.

The stone of which the spillway is constructed is weathered and the concrete crest has "broken off" in many places along the left one-half of the spillway. Neither the "cramps" nor reinforcement could be observed due to the amount of river flow. The right abutment between the spillway crest and the bedrock outcropping is approximately 4.3 feet wide on the top and the upstream and downstream faces are battered on 1 vertical to .125 horizontal slopes. The non-overflow section at the left abutment is of stone masonry construction and bolts were observed to be grouted into the stone. These bolts are believed to be the "cramps" mentioned previously. The non-overflow section has a top width of approximately 4 feet.

The non-overflow section of the spillway is a continuation of the spillway on the right side of the canal. A canal intake structure separates the two spillways. The top of the non-overflow section adjacent to the spillway is 5.5 feet above the spillway crest. The top of the canal intake structure is 8.6 feet above the spillway crest. One "drain" hole was noted at the base of the non-overflow section.

b. Canal Appurtenances

The canal appurtenances include an intake structure, a canal spillway, and an earth and rock fill embankment along the canal. These components are discussed in the following paragraphs.

The canal intake structure is a stone masonry structure with a concrete cap. The structure is abutted on the right by the non-overflow section of the dam and by a limestone outcrop. On the left, the intake structure is abutted by a limestone outcrop. The intake structure is approximately 18 feet wide, 60 feet long and 16 feet high. Currently, there are three timber gates mounted on the upstream face of the intake structure. Old photographs indicate that at one time, the intake structure contained at least four gates. The gates are reportedly operable. Wide longitudinal and vertical cracks were noted on the concrete cap and the downstream side of the intake structure.

The canal spillway is located just downstream of the intake structure and is depicted in Plates 1-2, 1-3, and 1-5. The canal spillway is probably constructed in a manner similar to the primary spillway. The canal spillway has an arch length of approximately 84 feet and a radius of approximately 56 feet. The spillway height is approximately 14.5 feet and is 1.3 feet higher than the crest of the main spillway. The canal spillway has been repaired by facing the downstream side with reinforced concrete. This repair was reportedly necessary due to severe weathering of the stones which occurred as the result of a leaky gate located in the center of the arch. This gate structure is currently closed off by the concrete wall and is, therefore, unobservable and inoperable. The canal spillway is abutted on the right by the non-overflow section of the dam, and on the left by a stone masonry abutment. This abutment is tied into a short earth or rock fill embankment extending between the abutment and the abandoned railroad grade. The top of the earth embankment is 0.7 foot above the crest of the canal spillway.

The short earth embankment between the left abutment of the canal spillway and the abandoned railroad grade is one of the most critical sections along the canal. This earth embankment has a crest width of approximately 10 feet and a downstream slope of 1 vertical to 1.4 horizontal. Shallow hand auger borings attempted in this embankment were obstructed within several feet of the surface. The surface material appears to be clay till fill classified as a CL according to the Unified Classification System.

Water was observed to be flowing around the downstream non-overflow section, the canal spillway and abutment and the adjacent earth embankment. A severe seepage and piping problem was noted on the earth embankment adjacent to the abutment of the canal spillway.

The earth embankment between the railroad grade and the powerhouse has a crest width of more than 70 feet and is less than 30 feet high. A sanitary sewer line crosses the canal and this earth embankment. Due to the extremely wide crest, this portion of the earth embankment probably is not critical with respect to instability. The sections of earth embankment adjacent to the powerhouse are more critical due to the steeper slopes and conduits passing through the embankment. An intake structure for the powerhouse is located in this section. The crest of this portion of the embankment is approximately 1.2 feet above the crest of the canal spillway and has a width of approximately 20 feet. The downstream slope is approximately 1.0 vertical to 1.7 horizontal. This embankment is presumed to be constructed of rock and clay till.

Adjacent to the powerhouse at the north end of the canal, the earth embankment is supported on the downstream side by a masonry wall, which may have been a foundation wall of one of the old mills. This wall is approximately 6.6 feet high. There is currently an inlet structure located on the side of the canal above this wall. Two intakes may have existed at one time as suggested by what appears to be two turbine shafts protruding from the downstream slope of the embankment. Reportedly, this portion of the embankment experienced

seepage problems at one time and was subsequently repaired. During the repair, the intake structure for the second turbine may have been removed.

The embankments are generally vegetated with grass and trees. The earth embankments are generally maintained at the critical locations (i.e., adjacent to the canal spillway and upstream of the powerhouse). No animal burrows were noted. No wave protection was noted or is necessary due to the extremely short fetches in the canal. With the exception of the seepage and piping of the earth embankment near the canal spillway, no visible signs of instability were noted.

c. Powerhouse and Control Structures

The powerhouse utilizes the available water power during peak electrical demand periods. The water flows to the turbine from the intake via a penstock and is controlled by the wicket gates in the turbine. The outlet is approximately 180 feet downstream from the intake and water flows from the turbine through an underground closed conduit or draft tube of unknown size. The penstock and discharge conduit were not observable during this inspection.

In addition to the powerhouse, it is believed that two turbines from an old mill may still be in place just downstream of the earth embankment adjacent to the powerhouse. What are believed to be shafts for the turbines are protuding from the base of the embankment and conduits may still be connected to the upstream intakes and the downstream outlet works. There appears to be only one outlet works for the powerhouse turbine and the abandoned turbines.

The intake for the powerhouse consists of a concrete drop structure with an invert elevation of approximately 834.9±. The outlet works appears to be a structure similar to a concrete box culvert with an invert elevation of approximately 817.6±. The invert elevation of the presumed existing intake to the abandoned turbines is at approximately 837.5± and presumably has the same outlet works as the powerhouse.

5.5 ASSESSMENT OF THE DAM FOUNDATION AND ABUTMENTS

The dam foundation and abutments are limestone (dolomite) bedrock. The bedrock along the abutments is jointed and bedded. The bedrock foundation could not be observed during the field investigation due to the amount of flow in the river. Due to the characteristics of the bedrock, seepage is the primary concern with respect to dam safety. Seepage through the bedrock may create solution channels around the structures, piping of the overlying soil and rock, and/or acceleration of the weathering processes which tend to reduce the strength of the rock.

The foundation of the dam is probably not designed to prevent seepage. Seepage through the foundation was observed, however, most of the seepage water appeared to be flowing at the contact of the structure with the foundation rather than through the foundation itself.

5.6 ASSESSMENT OF EARTH EMBANKMENTS

No formal existing slope stability analyses of the Lanesboro Dam could be found. No indications of deep-seated slope failures or significant surface sloughing were evident. Previous problems in the stability of the embankment were apparently due to seepage. Because of the relatively steep downstream slopes, the two most critical sections of the earth embankment, with respect to slope stability, are the embankment adjacent to the canal spillway and the embankments upstream of the powerhouse. The sections of the two critical portions of the embankments are depicted graphically on Plate 1-6.

Based on visual observation, the foundation for the embankment adjacent to the canal spillway appears to be bedrock. The foundation for the embankment upstream of the powerhouse is unknown, but is probably also bedrock. Thus, the foundation is probably competent. An assessment of the foundation stability, as related to seepage rather than shear strength, is discussed in Subsection 5.5.

An assessment of the embankment stability assumes that the foundation is competent. The embankment material appears to be clay till and rock,

which is considered to be a relatively stable and impervious material. If the embankment adjacent to the powerhouse was utilized as a railroad grade, adequate compaction was probably obtained. However, the embankment adjacent to the canal spillway may not have been constructed in accordance with current recommended construction practices.

The earth embankment adjacent to the canal intake and spillway probably does not meet the current dam safety guidelines. The minimum crest width recommended for an embankment of this type is approximately 13 feet and the maximum downstream slope recommended is 2.5 horizontal to 1 vertical.

Depending upon the embankment material, the earth embankment adjacent to the powerhouse may not meet the current design criteria and seepage would likely be more critical than shear stability. The minimum recommended design crest is approximately 14 feet and the maximum recommended downstream slope is approximately 2.5 horizontal to 1 vertical.

The presence of trees on the slopes do not appear to affect the stability of the embankments. Changes within the earth embankment which could precipitate a slope stability problem are surface erosion of the slopes, excessive seepage and internal erosion of the embankments or foundations, and overtopping the embankment by flood waters. Internal erosion of the slopes by excessive seepage is discussed in Section 5.7 of this report and overtopping the embankments is discussed in Section 3.4. Erosion of the slopes due to surface runoff will likely occur gradually and could probably be corrected as it occurs in the section of the embankment upstream of the powerhouse. However, due to the narrow crest width of the earth embankment adjacent to the canal spillway, it is possible that surface erosion could cut a channel and breach the embankment before repairs are possible.

5.7 ASSESSMENT OF SAFETY OF EARTH EMBANKMENTS AGAINST UNCONTROLLED SEEPAGE

The most probable cause of instability of the earth embankments is uncontrolled seepage. The two most critical locations with respect to

seepage related instability are adjacent to the canal spillway and the powerhouse. Seepage was observed adjacent to the canal spillway and seepage has reportedly been a problem near the powerhouse.

The characteristics of the earth embankment adjacent to the canal spillway, which increase the seriousness of potential seepage problems, are the low narrow crest, the adjacent masonry abutment, and the relatively steep slopes. A discussion with the operating personnel indicated that seepage and erosion has been a problem at this location for the last few years during periods of high water. At the time of the initial field investigation, the river was relatively high and severe seepage erosion and piping was noted. The water was seeping (more correctly, flowing) from the canal through the crest towards the abutment. The soil on the crest was falling into the flow path and forming a sink hole in the embankment crest. Most of the water flowing through the embankment was exiting through cracks in the abutment and at the interface of the abutment with the bedrock foundation. The quantity of flow through the abutment was estimated to be greater than 40 gpm. A subsequent field investigation was made when the river level was lowered. The quantity of water flowing through the abutment at this time was estimated to be less than 10 gpm. During the second field investigation, the sink hole, which had formed on the crest during high water, was dry and could be easily observed. At this time, the sink hole had developed into a channel on the crest and was approximately 1.5 feet deep, 2 feet wide, and extended from the upstream side of the crest to about mid-crest adjacent to the abutment. The soil at the bottom of the channel was a clay till fill. A small amount of sand, presumably remaining from the unsuccessful efforts to stop the erosion of the sink holes, was noticed on the bottom. A prolonged period of high water would probably have breached the embankment. A total breach would probably have resulted in a relatively rapid release of the water in the canal.

The earth embankment adjacent to the powerhouse is critical with respect to seepage primarily because of the conduits within the embankment and past history of seepage problems in this area. The previous seepage problem at this location may have been caused by the conduit from the abandoned intake structure, which was subsequently removed. The embankment

material at this location appears to be relatively strong and resistant to piping. Therefore, any instability from excessive seepage would probably be preceeded by evidence of relatively large quantities of water flowing through the embankment. The most critical location for seepage is along the conduits.

5.8 SLOPE PROTECTION

Slope protection with respect to wave erosion is generally not applicable due to the extremely small fetch distances in the canal.

5.9 SCOUR PROTECTION

No energy dissipation works or scour protection exist except for the bedrock foundation. The bedrock is a dolomite and is susceptible to erosion. The bedrock was observed to be scoured to a depth of approximately 4 feet on the right one-half of the spillway and to a maximum depth of approximately 11-1/2 feet on the left one-half of the spillway. The uneven scour may be due in part to the fact that more water flows over the left one-half of the spillway or to differences in the hardness of the rock. The maximum ultimate depth of the scour is estimated to be approximately 13.8 feet. No undermining of the spillway was observed.

5.10 CONCRETE AND MASONRY CONDITIONS

The downstream face of the stone masonry on the spillway is weathered, but generally in good condition. The concrete cap on the spillway crest is in poor condition and is "broken off" in several locations. The concrete cap on the canal intake structure is cracked and displaced. The concrete facing on the canal spillway is in good condition.

5.11 SUMMARY

The primary structures of the Lanesboro Dam that prevent an uncontrolled flow of water downstream are the spillway and the canal intake structure. Therefore, these are the most important structures with respect to the

safety of the dam. Sudden failure of the structures located downstream of the canal intake structure would result in the release of a limited amount of water. However, the structures downstream of the canal intake structure appear to have the most problems with respect to stability.

The following conclusions and recommendations are made regarding the foundation of the primary structures and the applicable appurtenant structures downstream of the canal intake structure.

a. Currently, the most critical problem for the Lanesboro Dam is excessive seepage within the earth embankment along the left abutment of the canal spillway. The seepage is resulting in piping, which is now in progress, and may breach the embankment. It is recommended that the earth embankment and the left abutment adjacent to the canal spillway be investigated in more detail with respect to seepage and piping and appropriate repairs undertaken. It is further recommended that this investigation be performed as soon as possible.

b. Based on the previous history of seepage problems and the presence of conduits through the embankment near the powerhouse, it is recommended that the conduits be located and investigated to determine the potential for excessive seepage which may cause stability problems.

c. The existing scour below the spillway is a potential problem which could lead to serious structural problems. It is recommended that the scour hole be repaired and that the crest of the dam be repaired to prevent concentrated flow.

d. The rock masonry is in generally good condition, considering its age. Recommendations regarding the concrete and the masonry structures are discussed in Section 6 of this report.

e. The earth embankments are probably stable provided seepage is controlled. However, portions of the embankments do not meet the current design criteria in all respects. In addition, seepage adjacent to the canal spillway and upstream of the powerhouse is present. Therefore,

it is recommended that the stability of the earth embankment adjacent to the left abutment of the canal spillway be investigated in more detail and appropriate action taken to correct any stability problems which are discovered. It is known that this portion of the embankment does not meet current design criteria with respect to crest width and maximum slope. It is therefore recommended that the crest width be increased and the downstream slope flattened in accordance with the current design criteria. It is recommended that the earth embankment adjacent to the powerhouse be investigated in more detail to determine if it satisfies current design criteria with respect to slope stability. This investigation should be undertaken in conjunction with the previously recommended seepage investigation. It is recommended that the earth embankments be monitored for signs of instability, such as seepage and erosion, on a regular basis, as a part of a regular inspection program and appropriate action taken if evidence of instability is observed. Trees and brush are present on the embankments. Due to the potential for loss of embankment material as a result of wind-downed trees and the potential for piping to develop along roots, the presence of trees on an embankment is usually considered to be undesirable. However, due to the thickness of the embankments, it is not evident that the trees and brush represent a potential hazard to the safety of the embankments. No recommendation for removal of the trees and brush is made.

SECTION 6
STRUCTURAL EVALUATION

6.1 BACKGROUND DATA

No stability analysis or design computations for the Lanesboro Dam were found and none are thought to exist. The current structural evaluation consists of visually observing the structure for signs of instability and structural distress, and performing an approximate stability analysis of the spillway. Verbal reports and historical documents were used as a basis for assumptions regarding the method of construction of the dam and the computations are based on values commonly used for similar structures.

6.2 ASSESSMENT OF STRUCTURAL STABILITY

The primary structural components of the Lanesboro Dam relating to structural stability are the spillway, canal intake structure, canal spillway and abutment, and the masonry wall (old mill foundation) along the north end of the canal. The structural stability of the spillway is discussed in Subsection 6.3 of this report. The recommended gravity design dimensions given in Subsection 6.3 of this report are also applicable to the canal spillway. The canal intake structure is a relatively massive gravity structure and no structural stability problems are thought to exist. However, signs of displacement indicate that the structure has been subjected to loads applied which were not taken into account in the original design. The masonry wall along the north (downstream) end of the canal appeared to be in good condition and no signs of instability were noted.

6.3 ASSESSMENT OF SPILLWAY STRUCTURAL STABILITY

The Lanesboro Dam is unusual for this geographic area in that the spillway is in the form of an arch constructed of large limestone blocks with no mortar. It has been reported that the masonry units were cut and placed by hand and "cramped" together with cables. The blocks were reportedly placed in such a manner that the structure performs as an arch dam.

However, stone masonry dams constructed in a similar manner are recommended to be designed as gravity structures and not to rely on arch action. Cursory analyses of the Lanesboro Dam were performed for both cases - gravity dam and arch dam.

The gravity design of similar stone masonry arch dams recommends that the batter of the downstream face be at least 1 vertical to 0.25 horizontal, that the width of the base equal at least .61 times the height of the dam, and the width of crest equal at least .41 times the height of the dam. In addition, the rise of the arch is recommended to be equal to at least one-tenth of the span. Arch action is desired in these types of dam, but is not taken into account in the design computation. Plate 1-4 indicates that the spillway does not meet this recommended design criteria. In addition, a preliminary computation using gravity design indicates that the spillway has a factor of safety less than 1.0 with respect to sliding and overturning. The dimensions of the spillway were computed by assuming batter of the upstream and downstream were similar to the batters observed on the right abutment discussed in Subsection 5.4 of this report. The actual dimensions are unknown.

If the spillway is assumed to perform as an arch, the maximum compressive stress at the base is computed to be less than approximately 370 psi. The allowable compressive stress on limestone was assumed to be between 400 and 800 psi. Therefore, the structure appears to be structurally adequate as an arch.

The reinforced concrete crest and the "cramps" in the stone tend to insure that the spillway will perform as an arch. However, the concrete crest is missing in many places and the "cramped" stones may be cracked from freeze-thaw cycles over the years, so that the effectiveness of the arch may be reduced. Further investigation of the structure with respect to structural stability should be performed to determine the effectiveness of the arch and to determine if the structure meets current dam safety guidelines.

6.4 ASSESSMENT OF STRUCTURAL STRENGTH

Preliminary calculations indicate that arch action is induced so that the spillway, the non-overflow section, and the canal spillway depend upon the compressive strength of the stone for stability. The type of stone used in construction of the spillway has an estimated life of less than 80 years. The life of the building stone refers to the period of time that it will resist attacks of weathering agents without undergoing disintegration or decay. Since the stones on the spillway are subjected to extreme weathering, the life of the stone is probably shortened to considerably less than the 80 years and the compressive strength is probably reduced. The deterioration may cause a problem if the stones crack and the "cramps" are ineffective in providing arch action.

6.5 SUMMARY OF RECOMMENDATIONS

A summary and recommendations are as follows:

a. A preliminary analysis indicates that the primary spillway depends upon arch action to maintain stability. The concrete crest and the "cramps" tend to insure the arch action is achieved. It is recommended that a more detailed investigation and analysis be performed to fully explore the structural stability of the Lanesboro Dam. It is recommended that the concrete cap on the spillway be repaired as soon as possible since displacement of the stones in an arch could precipitate a progressive failure of the dam.

b. The canal intake structure shows signs of displacement. It is recommended that the cause of displacement be evaluated and appropriate action taken.

APPENDIX A

REPORT OF FIELD INSPECTION

CHECKLIST

This checklist contains information obtained from visual observations on the day of the inspection. It is not intended that specific information in the checklist coincide exactly with the main report. Further study during preparation of the report may significantly alter previous judgments and conclusions as noted in the checklist.

NATIONAL DAM SAFETY
PROGRAM

GENERAL CHECKLIST

This form should be filled out by the team leader but should represent a consensus of the opinions and input of all team members.

1. a. Name of Dam LANESBORO DAM

   b. I.D. Number MN 517

2. Date of Inspection 30 MAY 78

3. Name or owner CITY OF LANESBORO

4. Location
   County FILLMORE

   Township 103N Range 10W Section 13,24

5. Is location shown on county map; or U.S.G.S. Quadsheet?

   (X) Yes (correctly)
   ( ) Yes (incorrectly)
   ( ) No - show correct location

6. Are items on inventory sheet correct?

   ( ) Yes (information is all correct)
   ( ) Yes (corrections attached)
   (X) No (completed form attached)

7. Type of dam (check all appropriate)

   ( ) Earth and/or rockfill (use form a)
   ( ) Concrete and /or masonry (gravity) (use form d)
   (X) Other
   Explain Masonry Arch

8. Year of construction 1868

9. Year(s) of major rehab 1972-73

10. Purpose of dam (check all appropriate)

   ( ) Flood Control
   ( ) Water Supply
   (X) Hydro Power
   ( ) Recreation
   ( ) Navigation
   ( ) Other
   Explain

11. Pool el. on day of inspection *6" above crest* 847.5±

12. Tailwater el. on day of inspection *22' below crest* 825.0±

13. Type of spillway and/or outlet (check all appropriate)

Controlled	Uncontrolled	Type
( )	( )	Pipe or Conduit
( )	( )	Chute or notch
( )	(X)	Overfall
( )	( )	Other
		Explain ________

14. General description of operating procedures. (Is there any formal documented hydraulic operating plan? If so, who operates?)

There is no documented operating plan. Dam is operated by Lloyd Smith (currently), Lanesboro Utilities Superintendent.

15. Is there any program of regular systematic inspection and maintainance? If so describe.

No program of regular, systematic inspection and maintenance is now in existance.

16. Do the following exist?

	Yes Inclosed	Yes, Not Inclosed	No	Don't Know	Where
Design data	( )	( )	(X)	( )	
Plans and specs	( )	( )	(X)	( )	
Shop drawings	( )	( )	(X)	( )	
As builts	( )	( )	(X)	( )	
O & M Manuals	( )	( )	(X)	( )	
History of const photos	( )	( )	(X)	( )	

Remarks ______________________________

Is there any formal flood warning system at the dam other than notification by local authorities?

( ) Yes, (X) No, Remarks ______________________________

18. Is there any evidence that the dam has ever been overtopped?

(X) No
( ) High water marks
( ) Erosion
( ) Evidence of repair
( ) Verbal reports
( ) Other
Explain ______________________________

19. Estimate the degree of lake siltation.

( ) No noticeable siltation in lake
( ) Some minor amount of siltation
( ) Lake has major amounts of siltation
(X) Lake is completely silted in

Remarks Level of silt in pool is reportedly about 3' below crest. Report substantially confirmed during inspection

LIST OF POTENTIAL DOWNSTREAM HAZARD

0.

		Type of Improvement (indicate number)										Loss Of Life Potential			Economic Loss Potential			Remarks
Approx. Ht. Above Stream (ft.)	Valley Distance (miles)	Occupied dwelling	Unoccupied dwelling	Agricultural Building	Industrial Building	Other Building	Road	Railroad	Urban Area	Dam (give ID number)	Other	Likely more than 4	Likely 4 or less	Possible, but not likely	Less than $___	$___ to $___	More than $___	
15-20	.2-.9	30	2	-	5	15	2	2	✓									C.M.StP+P RR CROSSES DOWNSTREAM
																		AT 1000' AND 5000' CSAH 8
																		CROSSES 1500' URBAN AREA
																		CLOSE TO RIVER ON SOUTH SIDE
																		OF RIVER - NORTH SIDE IS
																		SHEAR BLUFF
																		FLOODING WAS REPORTED IN
																		1965

21. The above list was ended because:

(X) We do not feel that points further downstream are seriously threatened by the dam
( ) We have already established a very high downstream hazard, but further downstream hazard exists
( ) We cannot tell, further study is needed
( ) Other
Explain ______

22. Give your overall opinion of the downstream hazard potential.

Team member	1. High	2. Significant	3. Low	Can't Decide
Gubbe	( )	( )	(X)	( )
Olson	( )	( )	(X)	( )
Salseng	( )	( )	(X)	( )

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (No permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than few	Excessive (Extensive community, industry or agriculture)

23. Are there any floodplain regulations or other constraints in force which would limit future development or future hazard downstream?

No ____ Yes \ Describe FIA HAS PREPARED A FLOOD HAZARD BOUNDARY MAP FOR LANESBORO

24. Is there any development in the emergency spillway area which may suffer damage due to flow through the spillway?

(X) N/A No emergency spillway
( ) No
( ) Yes, Describe ____________________

25. Check which item best describes the condition of the channel upstream of the lake.

(X) Clear of debris, trees, etc.
( ) Some minor debris in channel and a few trees periodically in channel
( ) Much debris in channel and many trees in channel
( ) Channel completely blocked by debris and trees

Remarks ____________________

26. Are there any type of instruments on the dam?

(X) No
( ) Monumentation
( ) Relief wells
( ) Piezometers
( ) Weirs, etc.
( ) Other
Explain ____________________

27. If planviews are not available at the time of the inspection, sketches and typical cross sections should be made on the back of these sheets to name and locate principal components of the dam.

28. Based on the visual inspection of the dam, are there any areas which deserve special consideration in regard to safety of the structure? (summarize from input on forms a thru g)

1. Seepage @ left abutment on right side of power canal
2. Leakage near upstream end of ~~second~~ power canal spillway
3. Deterioration of power canal intake control structure
4. Gate structure @ intake to power house.
5. Sewer crossing power canal
6. Power canal embankment near dam
7.
8.
9.
10.
11.
12.

Participants in the dam inspection:

Name	Title	Agency
L.W. GUBBE	TEAM LEADER	BARR ENGINEERING CO.
P. B. SOLSENG	STRUCTURAL/GEOTECHNICAL	BARR ENGINEERING CO.
W. J. OLSON	HYDRAULIC/HYDROLOGIC	BARR ENGINEERING CO.
M. KATSOULIS		M.D.N.R.

List of attached forms

(X) Inventory Form
( ) U.S.G.S. or County Map
(X) Form A Embankment Dam
( ) Form B Spillway
( ) Form C Conduit
(X) Form D Concrete Masonry or Tibmer Gravity Dam - 2
(X) Form E Powerhouse
(X) Form F Concrete Condition - 2
(X) Form G Site Geology
( ) Other
List:

FORM A - EMBANKMENT DAM

(If plans are available item no. 1 need not be completed.)

1. On a separate sheet, draw one or more sections through the dam. Show crest, width, height, slopes, major type(s) of materials, foundation treatment, provisions for internal drainage (if any), location of outlets, slope protection, upstream and downstream water surface, high water marks, eroded or damaged areas, seepage, etc. Describe features not adequately shown on sketch.

2. Based on the exposed material in the downstream channel and any other physical evidence. Describe the foundation and embankment material.

Foundation may consist of either bedrock or alluvium

3. Basis for foundation and embankment description.

(X) Borings

( ) Construction records

( ) Verbal testimony

(X) Visual observation

( ) Waterwell records

( ) Other explain

Shallow auger borings were taken in the embankment near Masonry dam; visual observation near Masonry dam indicated bedrock near surface.

4. Are there any signs of instability?

( ) Cracks
( ) Sloughing
( ) Irregularities in crest or waterline
(X) Excessively steep slopes
( ) History of sliding
( ) Other

Remarks No signs of instability were noted other then slopes appeared to be steep in places.

5. Give your opinion of the stability of the dam.

( ) Embankment has no visible stability problems and may meet criteria set forth in the guidelines
(X) Embankment has no visible stability problems but probably does not meet the criteria set forth in the guidelines
( ) Embankment has minor stability problems but unlikely to lead to failure
( ) Embankment has stability problems which if not corrected could lead to failure
( ) Embankment has serious stability problems which could lead to failure at any time
( ) Other
Explain the Slopes may not have an adequate Factor of Safety. The embankment near the left embankment abutment does have serious stability problems w/ respect to seepage

6. Is there any evidence of seepage?

Yes	No	N/A	Can't Tell	
( )	(X)	( )	( )	Downstream slope
( )	( )	(X)	( )	Downstream of dam
(X)	( )	( )	( )	Left abutment (looking downstream)
( )	( )	( )	( )	Right abutment (looking downstream)
( )	( )	( )	( )	Around structure
( )	( )	( )	( )	Other

Explain fully (quantity, turbidity, location, point source or general area, etc.) Left abutment: relatively large quantity of water flowing along left abutment in a concentrated flow path. Appears to flow relatively clear

7. Give your opinion of seriousness of seepage based on visual observations.

( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is presently a problem which if not corrected could lead to failure
(X) Serious problem which could lead to failure at any time

Remarks definite soil erosion appeared on surface of embankment near left abutment

8. Are there any toe drains or relief wells? No

Are they functioning? ______

Quantity of observed flow? Slight ( ) Moderate ( ) Heavy ( )

Not observalbe ( )

9. Is there any slope protection on the embankment? Yes (X) No ( )
(describe) grassed surface

10. Is there any evidence of erosion of embankment material?

Yes	No	N/A	Can't Tell	
( )	(X)	( )	( )	Upstream slope
( )	(X)	( )	( )	Downstream slope
( )	(X)	( )	( )	Crest
( )	(X)	( )	( )	Around structures

10. (Cont'd)

Yes	No	N/A	Can't Tell	
( )	( )	(X)	( )	Right abutment (looking downstream)
(X)	( )	( )	( )	Left abutment (looking downstream)
( )	( )	( )	( )	Others

Remarks Left abutment is eroding

11. Describe material being eroded - estimate uniform soil classification.

Sandy Clay (CL) to Clayey Sand (SC) on surface.
may have rocks below approximately 4'

12. Give your opinion of the seriousness of the erosion based on visual observations.

( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
(X) Is a problem which could lead to failure at any time

13. Is there any evidence to indicate that the embankment has ever been overtopped? Yes ( ) No (X)
(Explain)

14. General condition of dam - maintenance, mowing, trees in embankment, animal burrows, etc.

good, grass is on the crest, trees on the slopes
trees do not appear to occur on ~~Surface~~ crest & grass
is mowed on crest.

15. Summary

Based on your field observations list the items which you feel may represent a potential hazard to the embankment.

(1) SEEPAGE IN EARTH EMBANKMENT ALONG LEFT ABUTMENT

(2) EXCESSIVELY STEEP SLOPES

(3)

(4)

(5)

(6)

Signature(s) of Person(s) completing this report

FORM B - SPILLWAY SEE FORM D

1. Give name of feature inspected (as shown on drawings, common usage, etc.)

( ) Emergency spillway
( ) Primary spillway
( ) Other
Name ______________________________

2. If plans are available the following item need not be completed. On a separate sheet, draw a plan of the spillway and one or more cross-sections of the spillway which show dimensions, location of concrete sills, etc. Show the elevation of the top of the dam in relation to the spillway crest. If possible show maximum, minimum and normal pool and tailwater elevations. Describe features not adequately shown on the sketch.

____

____

____

____

____

____

____

3. Check all the applicable items which describe the spillway.

( ) Gated spillway - Type, Tainter ____ Roller ____ Stop log ____
( ) Lined with concrete or slope protection
( ) Concrete control sill
( ) Unlined in soil
( ) Unlined in rock

Remarks: ______________________________

____

____

____

4. Is there any evidence of erosion of the spillway itself?

Yes	No	N/A	Can't Tell	
( )	( )	( )	( )	Spillway floor
( )	( )	( )	( )	Spillway side slopes
( )	( )	( )	( )	Around control sill
( )	( )	( )	( )	Around spillway gates or control structure

5. Give your opinion of the seriousness of the erosion of the spillway proper.

( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at anytime.
( ) Not Applicable

6. Is there any evidence of erosion upstream or downstream of the spillway?

( ) Visual evidence _____ U.S. _____ D.S.
( ) Sounding data _____ U.S. _____ D.S.
( ) Flow pattern _____ U.S. _____ D.S.
( ) Operators Observation _____ U.S. _____ D.S.
( ) Other evidence ____

____

7. What is the condition of riprap?

( ) No riprap

( ) Badly displaced

( ) Occasional holes and pockets

( ) Rock deteriorated

( ) Rock sound and in good condition

( ) Other

8. Give your opinion of the seriousness of the upstream and downstream erosion.

( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at anytime.

9. Describe the material in which the spillway is constructed. Estimate the uniform soil classification if in soil or type of rock and formation if in rock.

____

____

____

10. Did you attempt to operate the gates?

( ) N/A. No gates.
( ) Yes, successfully.
( ) Yes, unsuccessfully.
( ) Yes, partial success.
( ) No, couldn't get permission.
( ) No necessary equipment not available.
( ) No, obviously inoperable
( ) No, but owner indicates that they are operable.

Remarks: ____________________________________

____

11. Are spillway gate normally

( ) N/A, no gates.
( ) open
( ) closed
( ) other
Explain ________________________________

____

12. Give your opinion of condition of gates.

( ) N/A. No gates.
( ) Gates appear to be in good condition and unlikely to cause problems in the foreseeable future.
( ) Gate have some problems not likely to impair operation
( ) Gate have some problems which could lead to failure during and emergency
( ) Gates are in such poor condition that failure could occur at anytime

Remarks: ____

____

13. In your opinion, what problems would failure of the gates to open cause?

( ) N/A. No gates
( ) Little or none
( ) Would make drawing down the lake difficult
( ) Would partially reduce the ability to safely pass a flood
( ) Would drastically reduce the ability to safely pass a flood
( ) Other ____

____

14. In your opinion, what problems would a failure of the gates that permitted uncontrolled release of water cause?

( ) N/A. No gates
( ) Little or none
( ) Would drain lake, but no safety problems
( ) May cause serious erosion of dam
( ) Could release enough water to be a flood hazard
( ) Other ____

____

15. Wall drains and floor weepholes

( ) None
( ) Generally appear open and functioning
( ) Generally appear non functioning
( ) Amount of flow observed
None ( )
Trickle ( )
Moderate ( )
Heavy ( )

16. Give your opinion of the general condition of the spillway.

____

____

17. Are there any obstruction to flow through the spillway?
( ) Yes ( ) No

Describe flow pattern: ____

____

____

18. In your opinion would an abnormally large spillway discharge have a tendency to erode the embankment?
( ) No
( ) Yes
Describe ____

____

____

19. Summary

Based on your field observations list the items which you feel may represent a potential hazard to the embankment.

(1) ____

(2) ____

(3) ____

(4) ____

(5) ____

(6) ____

Signature(s) of Person(s) responsible for this section

____

____

____

FORM C - CONDUIT AND CONDUIT ENERGY DISSIPATION

1. Give name of the feature described in this section (as shown on drawings, common usage, etc.)

( ) Primary spillway
( ) Outlet works
( ) Other
Name ______________________________

2. If plans are available the following item need not be completed. On a separate sheet, sketch the outlet pipe or conduit including inlet and outlet (stilling basin). Show location of control structure if any and all pertinent dimensions and elevations of the outlet pipe or conduit. Describe features not adequately shown on the sketch or in photos.

____

____

____

____

____

3. Type of conduit or pipe.

Controlled Discharge	Uncontrolled Discharge	
( )	( )	Concrete pipe
( )	( )	CMP
( )	( )	Other

Remarks ______________________________

____

____

4. Does any conduit or pipe operational data exist?

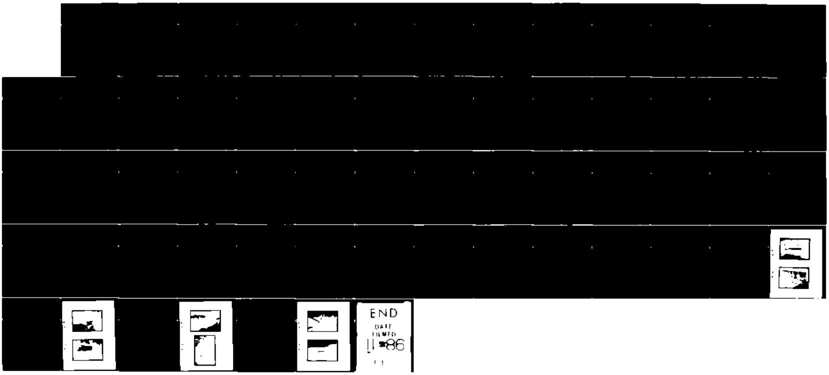
( ) Yes, data is included.
( ) Yes, but not included. Explain. ______________________________

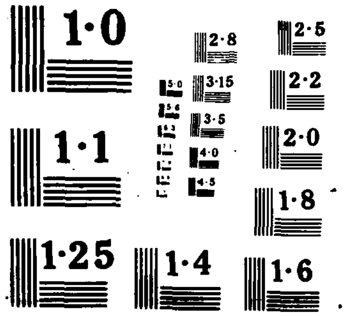
____

( ) Don't know
( ) No

AD-A172 943 NATIONAL DAM SAFETY PROGRAM INSPECTION REPORT SOUTH BRANCH ROOT RIVER LAN..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JUL 78 2/2

UNCLASSIFIED F/G 13/13 NL




1.0
2.8
2.5
3.15
2.2
3.5
1.1
2.0
4.0
4.5
1.8
1.25
1.4
1.6

5. How much of conduit could be inspected? ______________________

____

____

____

6. Describe any apparent deviations in horizontal or vertical alignment.

____

____

____

7. Is there any movement at conduit joints?

( ) Joints unobservable

( ) Separation (describe locations and estimated amount of movements)

____

____

____

( ) No apparent movements observed on joints which can be inspected.

8. Is there any evidence of leakage into, out of, or around the conduit or pipe?

( ) No ( ) Yes

Describe ____

____

____

9. Give your opinion of the overall structural integrity of the pipe or conduit.

( ) Majority of conduit is unobservable

( ) In good workable condition and unlikely to become a problem in the foreseeable future

( ) The conduit has some structural problems which are not likely to lead to failure during an emergency

9. (Cont'd)

( ) The conduit has some serious structural problems which could lead to failure if the defects are not corrected

( ) The conduit has serious structural problems which could lead to failure at any time.

Remarks: ____

____

____

10. Did you attempt to operate the gates or control valve?

( ) N/A. No gates or valves
( ) Yes, successfully
( ) Yes, unsuccessfully
( ) Yes, partial success
( ) No, couldn't get permission
( ) No, necessary equipment not available
( ) No, obviously inoperable
( ) No, but owner operates regularly

Remarks: ____

____

11. Is gate or control valve normally

( ) N/A. No gates or valves
( ) open
( ) closed
( ) don't know
( ) other
Explain ____

____

12. Give your opinion of condition of gates or valves?

( ) N/A. No gates or valves

( ) Gates appear to be in good condition and unlikely to cause problems in the foreseeable future

( ) Gates have some problems not likely to impair operation

( ) Gates have some problems which could lead to failure during an emergency

( ) Gates are in such poor condition that failure could occur at any time

12. (Cont'd)

Remarks: ____

____

____

13. In your opinion, what problems would failure of the gates or valves to open cause?

( ) N/A. No gates or valves
( ) Little or none
( ) Would make drawing down the lake difficult
( ) Would partially reduce the ability to safely pass a flood
( ) Would drastically reduce the ability to safely pass a flood
( ) Other
Explain ____

____

14. In your opinion, what problems would a failure of the gates or valves that permitted uncontrolled release of water cause?

( ) N/A. No gates or valves
( ) Little or none
( ) Would drain lake, but no safety problem
( ) May cause serious erosion of dam
( ) Could release enough water to be a flood hazard
( ) Other
Explain ____

____

15. What is the condition of the metal pipe?

( ) Majority of pipe is unobservalbe
( ) N/A (If concrete pipe or conduit complete Form F, "Surface Condition of Concrete")
( ) Sound metal - no visible problems
( ) Metal beginning to rust or corrode
( ) Metal has serious rust and corrosion problems, some closed cracks
( ) Metal has massive amounts of rust, corrosion, and open cracks

16. What is your opinion of the seriousness of the deterioration of the metal pipe?

( ) N/A
( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at any time

17. Is there any evidence of erosion?

Yes	No	N/A	Can't Tell	
( )	( )	( )	( )	Upstream
( )	( )	( )	( )	Downstream

18. What is the condition of the riprap?

( ) No riprap
( ) Badly displaced
( ) Occasional holes and pockets
( ) Rock deteriorated
( ) Sound and in good condition
( ) Other

19. Give your opinion of the seriousness of the erosion.

( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at any time

20. Summary

Based on your field observations list the items which you feel may represent a potential hazard.

(1) ______________________________

(2) ______________________________

(3) ______________________________

20. (Cont'd)

(4) ______________________________

(5) ______________________________

(6) ______________________________

Signature(s) of Person(s) completing this report

____

____

____

D-1

FORM D - CONCRETE, MASONRY, OR TIMBER GRAVITY DAM

1. (If plans are available the following need not be completed.) On a separate sheet, draw one or more sections through the dam. Show crest width, height, major types of foundation, water surface upstream and downstream and any pertinent features. On a plan or elevation, show location by dimension of outlets and other features. Describe features not adequately shown on sketch. Identify foundation treatment measures taken.

THIS FORM, D-1, IS APPLICABLE TO THE PRIMARY SPILLWAY; U.S. NON-OVERFLOW SECTION AND THE INTAKE STRUCTURE TO THE POWER CANAL ONLY

2. Based on the exposed material in the downstream channel and any other physical evidence, describe the foundation material.

Foundation appears to be limestone bed rock, bedding planes nearly horizontal

3. Basis for foundation description

( ) Borings

( ) Construction records

( ) Verbal testimony

(X) Visual observation

( ) Waterwell records

( ) Other - Explain

3. (Cont'd)

General geology of area, limestone outcrops at both abutments

4. Are there any signs of instability (i.e. sliding, overturning, bearing)?

(X) No signs of instability observed
( ) Cracks in the concrete, other than temperature or deterioration cracks
( ) Displacement at joints
( ) Evidence of movement
( ) History of sliding or tipping
( ) Other

Remarks: ______

5. Give your opinion of the stability of the dam based on the observations from question 4.

( ) Structure has no visible stability problems and may meet criteria set forth in the guidelines
( ) Structure has no visible stability problems but probably does not meet the criteria set forth in the guidelines
( ) Structure has minor stability problems but unlikely to lead to failure
( ) Structure has stability problems which if not corrected could lead to failure
( ) Structure has serious stability problems which could lead to failure at anytime
(X) Other
Explain Dam is masonry arch - ends terminate in bedrock outcrops

6. For concrete structures Form F (Surface Condition of Concrete) should be completed. Are there any items listed on Form F which may be caused by overstress of structural members rather than concrete deterioration?

6. (Cont'd)

( ) No N/A
( ) No
( ) Cracks due to overstress in bending on tension
( ) Cracks due to shear or bearing
( ) Spalls or other deterioration due to overstress
(X) Large deflections

General Locations GATE STRUCTURE AT INTAKE TO POWER CANAL

7. Give your opinion of the ability of the structural components to carry the applied loads using modern design criteria.

(X) Structure has no visible structural strength problems and may meet criteria set forth in the guidelines
( ) Structure has no visible structural strength problems but probably does not meet the criteria set forth in the guidelines
( ) Structure has minor structural strength problems but unlikely to lead to failure
( ) Structure has structural strength problems which if not corrected could lead to failure
( ) Structure has serious structural strength problems which could lead to failure at anytime
( ) Other
Explain

8. Are there any loads on the structure which may not have been included in the original design but could be causing overstress in some structural components?

( ) None observed
(X) Large silt deposits on upstream face
( ) Increased load due to heavier traffic
( ) Additional or larger equipment loads (cranes, generators, dead load)

Remarks: Silt load on upstream face probably not included in original design - may or may not have a significant affect on stresses

9. Are there any drains or weepholes which appear to be functioning improperly?

(X) No drains or weepholes noted
( ) Generally yes
( ) Generally no
( ) Can't tell

10. Is there evidence of seepage? (Seepage at embankment tie-ins should be covered in section on embankment dams.)

Yes	No	N/A	Can't Tell	
( )	( )	( )	(X)	Downstream of dam
(X)	( )	( )	( )	Left abutment (looking downstream)
( )	(X)	( )	( )	Right abutment (looking downstream)
(X)	( )	( )	( )	Through structure
( )	( )	( )	( )	Other (relief drains)

Explain fully (quality, turbidity, location, point source of general area, etc.) and/or locate evidence of seepage on a profile and plan sketch.

More correctly, there is leakage between the masonry units and between the masonry and the bedrock. Piping should not be a problem but leakage may tend to accelerate weathering processes.

11. Give your opinion of the seriousness of the seepage based on field observations.

( ) No seepage noted
( ) Unlikely that it will become a problem in the foreseeable future
(X) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is presently a problem which if not corrected could lead to failure
( ) Serious problem which could lead to failure at anytime
( ) Other

Remarks: see above

12. If gravity dam is not designed as an overflow structure do not complete items 12 through 24.

Check the type of spillway section(s) included in the gravity* section

(X) Ungated fixed crest
( ) Fixed crest with flash boards
( ) Tainter gate
( ) Stoplog
( ) Roller gate
( ) Other
Describe *Note: dam is masonry arch

13. Give your opinion of condition of gates

(X) N/A. No gates
( ) Gates appear to be in good condition and unlikely to cause problems in the foreseeable future
( ) Gates have some problems not likely to impair operation
( ) Gates have some problems which could lead to failure during an emergency
( ) Gates are in such poor condition that failure could occur at anytime

Remarks:

14. Give your opinion of condition of stop logs or flash boards

(X) N/A. No stop logs or flash boards
( ) Stop logs/flash boards appear to be in good condition
( ) Stop logs/flash boards have some problem areas but are not likely to impair operation
( ) Stop logs/flash boards have serious problems which could cause operation problems

15. Describe how flash boards are controlled and what head controls them

(X) N/A. No flash board
( ) Description

16. Where are stop logs kept when not in use?

(X) N/A. No stop logs
( ) Location ______________________________

____

17. Did you attempt to operate the gates?

(X) N/A. No gates
( ) Yes, successfully
( ) Yes, unsuccessfully
( ) Yes, partial success
( ) No, couldn't get permission
( ) No, necessary equipment not available
( ) No, obviously inoperable
( ) No, but owner indicates that they are operable

Remarks: ______________________________________

____

18. Are spillway gates normally

(X) N/A. No gates
( ) Open
( ) Closed
( ) Other
Explain ______________________________

____

19. In your opinion, what problems would failure of the gates to open cause?

(X) N/A. No gates
( ) Little or none
( ) Would make drawing down the lake difficult
( ) Would partially reduce the ability to safely pass a flood
( ) Would drastically reduce the ability to safely pass a flood
( ) Other ______________________________

____

20. In your opinion, what problems would a failure of the gates that permitted uncontrolled release of water cause?

- (X) N/A. No gates
- ( ) Little or none
- ( ) Would drain lake, but no safety problem
- ( ) May cause serious erosion of dam
- ( ) Could release enough water to be a flood hazard
- ( ) Other ____________________

____

21. Is there any evidence of erosion or deterioration of the spillway portion of the dam?

Yes	No	N/A	Can't Tell	
(X)	( )	( )	( )	Spillway floor
(X)	( )	( )	( )	Spillway side slopes
(X)	( )	( )	( )	Around control sill or overflow ogee
( )	(X)	( )	( )	Around spillway gates or control structure

22. Give your opinion of the seriousness of the erosion of the spillway portion of the dam.

- ( ) Unlikely that it will become a problem in the foreseeable future
- (X) May or may not become a problem
- ( ) Is a problem but not likely to lead to failure
- ( ) Is a problem which if not corrected could lead to failure
- ( ) Is a serious problem which could lead to failure at anytime
- ( ) N/A

23. Is there any evidence of erosion upstream or downstream of the spillway?

		U.S.	D.S.
(—)	Visual evidence	____	X
(—)	Sounding data	____	X
(—)	Flow pattern	X	____
(—)	Operators observation	____	X
( )	Other evidence ____________________		

____

24. Is there any evidence of undermining of the structure due to erosion?

(✓) No
( ) Yes, see attached sketch or map
( ) Yes, describe location(s) and amount(s) of erosion ______

______

______

25. Is there an upstream or downstream riprap apron? No.

a. Is it visible? U.S. ____ D.S. ____

b. What is its condition?

( ) Intact
( ) Ends undermined or eroded
( ) Rock displaced or missing

26. Give your opinion of the seriousness of the erosion.

( ) No erosion noted
( ) Unlikely that it will become a problem in the foreseeable future
(✓) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at anytime
( ) Other
Remarks: ______

______

______

27. Based on field observations list items believed to represent significant potential hazards to the integrity of the dam.

(1) CREST IS IRREGULAR CAUSING MORE FLOW OVER
(2) LEFT 1/2 OF SPILLWAY WHICH RESULTS IN MORE SEVERE SCOUR
(3) WATER FLOWING THROUGH THE DAM MAY OR MAY
(4) NOT BE A PROBLEM

27. (Cont'd)

(5) ______________________________

(6) ______________________________

(7) ______________________________

(8) ______________________________

(9) ______________________________

Signature(s) of Person(s) completing this section

____

____

____

D-2

FORM D - CONCRETE, MASONRY, OR TIMBER GRAVITY DAM

1. (If plans are available the following need not be completed.) On a separate sheet, draw one or more sections through the dam. Show crest width, height, major types of foundation, water surface upstream and downstream and any pertinent features. On a plan or elevation, show location by dimension of outlets and other features. Describe features not adequately shown on sketch. Identify foundation treatment measures taken.

THIS FORM, (D-2), IS APPLICABLE TO THE D.S TRAINING WALL AND SECONDARY SPILLWAY

2. Based on the exposed material in the downstream channel and any other physical evidence, describe the foundation material.

BEDROCK

3. Basis for foundation description

( ) Borings

( ) Construction records

( ) Verbal testimony

(✓) Visual observation

( ) Waterwell records

( ) Other - Explain

3. (Cont'd)

4. Are there any signs of instability (i.e. sliding, overturning, bearing)?

(X) No signs of instability observed
( ) Cracks in the concrete, other than temperature or deterioration cracks
( ) Displacement at joints
( ) Evidence of movement
( ) History of sliding or tipping
( ) Other

Remarks:

5. Give your opinion of the stability of the dam based on the observations from question 4.

( ) Structure has no visible stability problems and may meet criteria set forth in the guidelines
( ) Structure has no visible stability problems but probably does not meet the criteria set forth in the guidelines
( ) Structure has minor stability problems but unlikely to lead to failure
( ) Structure has stability problems which if not corrected could lead to failure
( ) Structure has serious stability problems which could lead to failure at anytime
(X) Other
Explain DAM IS MASONRY ARCH - ENDS TERMINATE IN BEDROCK OUTCROPS

6. For concrete structures Form F (Surface Condition of Concrete) should be completed. Are there any items listed on Form F which may be caused by overstress of structural members rather than concrete deterioration?

6. (Cont'd)

( ) No N/A
(✓) No
( ) Cracks due to overstress in bending on tension
( ) Cracks due to shear or bearing
( ) Spalls or other deterioration due to overstress
( ) Large deflections

General Locations THIS APPLIES TO D.S. FACE OF SPILLWAY WHICH WAS REPAIRED IN 1972-1974

7. Give your opinion of the ability of the structural components to carry the applied loads using modern design criteria.

(✓) Structure has no visible structural strength problems and may meet criteria set forth in the guidelines
( ) Structure has no visible structural strength problems but probably does not meet the criteria set forth in the guidelines
( ) Structure has minor structural strength problems but unlikely to lead to failure
( ) Structure has structural strength problems which if not corrected could lead to failure
( ) Structure has serious structural strength problems which could lead to failure at anytime
( ) Other
Explain

8. Are there any loads on the structure which may not have been included in the original design but could be causing overstress in some structural components?

(✓) None observed
( ) Large silt deposits on upstream face
( ) Increased load due to heavier traffic
( ) Additional or larger equipment loads (cranes, generators, dead load)

Remarks:

9. Are there any drains or weepholes which appear to be functioning improperly?

(X) No drains or weepholes noted
( ) Generally yes
( ) Generally no
( ) Can't tell

10. Is there evidence of seepage? (Seepage at embankment tie-ins should be covered in section on embankment dams.)

Yes	No	N/A	Can't Tell	
(X)	( )	( )	( )	Downstream of dam
(X)	( )	( )	( )	Left abutment (looking downstream)
(X)	( )	( )	( )	Right abutment (looking downstream)
( )	( )	( )	(X)	Through structure
( )	( )	( )	( )	Other (relief drains)

Explain fully (quality, turbidity, location, point source of general area, etc.) and/or locate evidence of seepage on a profile and plan sketch.

THERE IS WATER FLOWING THROUGH AND UNDER THE D.S. TRAINING WALL, WATER IS FLOWING UNDER THE CONCRETE FACING AND WATER IS FLOWING THROUGH AND UNDER THE LEFT ABUTMENT

11. Give your opinion of the seriousness of the seepage based on field observations.

( ) No seepage noted
( ) Unlikely that it will become a problem in the foreseeable future
(X) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is presently a problem which if not corrected could lead to failure
( ) Serious problem which could lead to failure at anytime
( ) Other

Remarks: ______

12. If gravity dam is not designed as an overflow structure do not complete items 12 through 21.

Check the type of spillway section(s) included in the gravity section

(✓) Ungated fixed crest
( ) Fixed crest with flash boards
( ) Tainter gate
( ) Stoplog
( ) Roller gate
( ) Other

Describe DAM IS MASONRY ARCH

13. Give your opinion of condition of gates

(✓) N/A. No gates
( ) Gates appear to be in good condition and unlikely to cause problems in the foreseeable future
( ) Gates have some problems not likely to impair operation
( ) Gates have some problems which could lead to failure during an emergency
( ) Gates are in such poor condition that failure could occur at anytime

Remarks: ______

14. Give your opinion of condition of stop logs or flash boards

(✓) N/A. No stop logs or flash boards
( ) Stop logs/flash boards appear to be in good condition
( ) Stop logs/flash boards have some problem areas but are not likely to impair operation
( ) Stop logs/flash boards have serious problems which could cause operation problems

15. Describe how flash boards are controlled and what head controls them

(✓) N/A. No flash board
( ) Description ______

16. Where are stop logs kept when not in use?

(✓) N/A. No stop logs
( ) Location ______________________________

____

17. Did you attempt to operate the gates?

(✓) N/A. No gates
( ) Yes, successfully
( ) Yes, unsuccessfully
( ) Yes, partial success
( ) No, couldn't get permission
( ) No, necessary equipment not available
( ) No, obviously inoperable
( ) No, but owner indicates that they are operable

Remarks: ______________________________

____

18. Are spillway gates normally

(✓) N/A. No gates
( ) Open
( ) Closed
( ) Other
Explain ______________________________

____

19. In your opinion, what problems would failure of the gates to open cause?

(✓) N/A. No gates
( ) Little or none
( ) Would make drawing down the lake difficult
( ) Would partially reduce the ability to safely pass a flood
( ) Would drastically reduce the ability to safely pass a flood
( ) Other ______________________________

____

20. In your opinion, what problems would a failure of the gates that permitted uncontrolled release of water cause?

( ) N/A. No gates
( ) Little or none
( ) Would drain lake, but no safety problem
( ) May cause serious erosion of dam
( ) Could release enough water to be a flood hazard
( ) Other ______________________________________

____

21. Is there any evidence of erosion or deterioration of the spillway portion of the dam?

Yes	No	N/A	Can't Tell	
( )	( )	( )	( )	Spillway floor
( )	( )	( )	( )	Spillway side slopes
( )	( )	( )	( )	Around control sill or overflow ogee
( )	( )	( )	( )	Around spillway gates or control structure

22. Give your opinion of the seriousness of the erosion of the spillway portion of the dam.

( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at anytime
( ) N/A

23. Is there any evidence of erosion upstream or downstream of the spillway?

( )	Visual evidence	____U.S.	____D.S.
( )	Sounding data	____U.S.	____D.S.
( )	Flow pattern	____U.S.	____D.S.
( )	Operators observation	____U.S.	____D.S.

( ) Other evidence NO EVIDENCE

____

24. Is there any evidence of undermining of the structure due to erosion?

(✓) No
( ) Yes, see attached sketch or map
( ) Yes, describe location(s) and amount(s) of erosion ______

____

____

25. Is there an upstream or downstream riprap apron? NO

a. Is it visible? U.S. _____ D.S. _____

b. What is its condition?

( ) Intact
( ) Ends undermined or eroded
( ) Rock displaced or missing

26. Give your opinion of the seriousness of the erosion.

(✓) No erosion noted
( ) Unlikely that it will become a problem in the foreseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at anytime
( ) Other
Remarks: ____

____

____

27. Based on field observations list items believed to represent significant potential hazards to the integrity of the dam.

(1) WATER FLOWING THROUGH THE TRAINING WALL
(2) AND ABUTMENTS MAY OR MAY NOT BE A PROBLEM.
(3) WATER FLOWING UNDER THE STRUCTURES MAY OR
(4) MAY NOT BE A PROBLEM

27. (Cont'd)

(5) ______________________________

(6) ______________________________

(7) ______________________________

(8) ______________________________

(9) ______________________________

Signature(s) of Person(s) completing this section

____

____

____

FORM E - POWERHOUSE

1. Does the Powerhouse function as part of the dam and retain water?

( ) Yes (X) No. Separate Powerhouse

2. Is the power generation equipment still in place and functioning?

( ) Not in place ( ) In place, not functioning
(X) In place and functioning

3. Are there any signs of instability (i.e. sliding, overturning, bearing)?

(X) No signs of instability observed
( ) Cracks in the concrete, other than temperature or deterioration cracks
( ) Displacement at joints
( ) Evidence of movement
( ) History of sliding or tipping
( ) Other

Remarks: ______________________________

____

4. Give your opinion of the stability of the powerhouse based on the observations from question 3.

(X) Structure has no visible stability problems and may meet criteria set forth in the guidelines
( ) Structure has no visible stability problems but probably does not meet the criteria set forth in the guidelines
( ) Structure has minor stability problems but unlikely to lead to failure
( ) Structure has serious stability problems which could lead to failure at any time
( ) Other
Explain ______________________________

____

5. For concrete structures form F (surface condition of concrete) should be completed. Are there any items listed on form F which maybe caused by overstress of structural members rather than concrete deterioration?

(X) No signs of overstress noted
( ) Cracks due to overstress in bending or tension
( ) Cracks due to shear or bearing
( ) Spalls or other deterioration due to overstress
( ) Large deflections

General Location: ____________________

____

____

6. Are there any loads on the structure which may not have been included in the original design but could be causing overstress in some structural components?

(X) None observed
( ) Large silt deposits on upstream face
( ) Increased load due to heavier traffic
( ) Additional or larger equipment loads (cranes, generators, dead load)

Remarks: ____________________

____

7. Give your opinion of the ability of the structural components to carry the applied loads using modern design criteria.

(X) Structure has no visible structural strength problems and may meet criteria set forth in the guidelines
( ) Structure has no visible structural strength problems but probably does not meet the criteria set forth in the guidelines
( ) Structure has minor structural strength problems but unlikely to lead to failure
( ) Structure has structural strength problems which if not corrected could lead to failure
( ) Structure has serious structural strength problems which could lead to failure at any time
( ) Other
Explain ____________________

____

8. Are there any drains or weepholes which appear to be functioning improperly?

- (X) No drains or weepholes noted
- ( ) Generally yes
- ( ) Generally no
- ( ) Can't tell

9. Is there evidence of seepage?
(Seepage at embankment tie-ins should be covered in section on embankment dams)

Yes	No	N/A	Can't Tell	
( )	(X)	( )	( )	Downstream of powerhouse
( )	(X)	( )	( )	Left side (looking downstream)
( )	(X)	( )	( )	Right side (looking downstream)
( )	(—)	( )	( )	Through structure
( )	(—)	( )	( )	Other (relief drains)

Explain fully (quality, turbidity, location, point source of general area etc.) and/or locate evidence of seepage on a profile and plan sketch.

10. Give your opinion of the seriousness of the seepage based on field observations.

- ( ) No seepage noted.
- ( ) Unlikely that it will become a problem in the foreseeable future
- ( ) May or may not become a problem
- ( ) Is a problem but not likely to lead to failure
- ( ) Is presently a problem which if not corrected could lead to failure
- ( ) Serious problem which could lead to failure at any time
- ( ) Other

Remarks:

11. Type of powerhouse gates

( ) N/A gates removed openings permanently sealed.
(X) Slide gates
( ) Stop logs
( ) Tainter gate
( ) Other ______________________________

____

____

12. Did you attempt to operate the gates?

( ) N/A. No gates
( ) Yes, successfully
(X) Yes, unsuccessfully
( ) Yes, partial success
( ) No, couldn't get permission
( ) No necessary equipment not available
( ) No, ovbiously inoperable
( ) No, but owner indicates that they are operable.

Remarks: ______________________________

____

13. Are ~~spillway~~ powerhouse gates normally

( ) N/A. No gates
(X) open
( ) closed
( ) other
Explain water flow controlled by wicket gates in turbine

14. Give your opinion of condition of gates.

( ) N/A. No gates
( ) Gates appear to be in good condition and unlikely to cause problems in the forseeable future
( ) Gates have some problems not likely to impair operation
(X) Gates have some problems which could lead to failure during an emergency
( ) Gates are in such poor condition that failure could occure at any time

Remarks: Timber gate disc in poor condition

____

14. Give your opinion of condition of gates.

( ) N/A. No gates
( ) Gates appear to be in good condition and unlikely to cause problems in the forseeable future
( ) Gates have some problems not likely to impair operation
(X) Gates have some problems which could lead to failure during an emergency
( ) Gates are in such poor condition that failure could occur at any time

Remarks: ______________________

15. In your opinion, what problems would failure of the gates to open cause?

( ) N/A. No gates
( ) Little or none
( ) Would make drawing down the lake difficult
( ) Would partially reduce the ability to safely pass a flood
( ) Would drastically reduce the ability to safely pass a flood
( ) Other operational problems - may endanger safety of power house

16. In your opinion, what problems would a failure of the gates that permitted uncontrolled release of water cause?

( ) N/A. No gates
( ) Little or none
( ) Would drain lake, but no safety problems
( ) May cause serious erosion of dam
( ) Could release enough water to be a flood hazard
( ) Other may endanger power house

17. Is there any evidence of erosion upstream or downstream of the powerhouse?

( ) Visual evidence ___U.S. ____D.S.
( ) Sounding data ___U.S. ____D.S.
( ) Flow Pattern ___U.S. ____D.S
( ) Operators Observation ____U.S. ____D.S.
( ) Other evidence None

18. What is the condition of riprap

(X) No riprap
( ) Badly displaced
( ) Occasional holes and pockets
( ) Rock deteriorated

19. Are there any obstruction to flow through the powerhouse?

( ) Yes (✓) No

Describe flow pattern: ______________________________

20. In your opinion would an abnormally large powerhouse discharge have a tendency to erode the embankment?

(X) No
( ) Yes
Describe ______________________________

21. Based on your visual observations list any conditions which you believe may have a potential affect on the integrity of the dam.

(1) ______________________________

(2) ______________________________

(3) ______________________________

(4) ______________________________

(5) ______________________________

(6) ______________________________

Signature(s) of person(s)
completing this section

____

____

____

FORM F - SURFACE CONDITION OF CONCRETE
(From ACI Report 65-67)

1. Identify the feature for which this section applies.

Gate structure at intake to power canal

2. General condition of concrete

( ) Good
( ) Satisfactory
(X) Poor

Remarks: Badly cracked

3. Cracks (X) Yes ( ) No

Describe downstream wall at gate structure displaced about 1½" downward and 2" to the left. Cover slab badly cracked appears to be result of settlement of fill inside structure

Direction
(X) Longitudinal
(X) Transfers
( ) Vertical
( ) Diagonal
( ) Random

Maximum Width
( ) fine (less than 1 mm or 3/64")
( ) medium (1 mm to 2 mm or 3/64" to 5/64")
(X) wide (more than 2 mm or more than 5/64")

Type
(X) Pattern cracking
( ) Checking
( ) Hariline cracking
( ) D-cracking

Mineralization
( ) Leaching
( ) Stalactites
( ) Stalagmites

4. Scaling ( ) Yes (X) No
Describe

4. (Cont'd)

Severity
- ( ) Light (C.A. not exposed)
- ( ) Medium (1/2 to 1 cm or 13/64" to 25/64", C.A. exposed)
- ( ) Severe (C.A. clearly exposed and stands out)
- ( ) Very severe (loss of C.A.)

5. Popouts ( ) Yes (X) No

Describe ______________________________

____

____

Size
- ( ) Small (less than 1 cm diameter or 25/64" diameter)
- ( ) Medium (1 to 5 cm diameter or 25/64" to 2" diameter)
- ( ) Large (more than 5 cm diameter or 2" diameter)

6. Spalls ( ) Yes (X) No

Describe ______________________________

____

____

Size
- ( ) Small (less than 2 cm deep and 15 cm long or 3/4" deep and 6" long)
- ( ) Large

7. Is(are) there any?

- ( ) None
- ( ) Pitting
- ( ) Dusting
- ( ) Honeycomb
- ( ) Stains
- (X) Exposed steel
- (X) Previous patching or other repair
- ( ) Chemical attach

7. (Cont'd)

Describe

some reinforcing steel exposed in cracks in canal slab. Cracks were at one time sealed with asphalt but have reopened

8. In your opinion, what is the effect of the condition of the concrete on the safety of the dam?

(X) Little or none
( ) Aesthetic problems but nothing that would effect the integrity of the structure.
( ) May create operational problems, but no safety problem
( ) If uncorrected, could eventually become a safety problem
( ) It is a safety problem that could result in a large uncontrolled release of water
( ) Other

Explain *Water in canal is controlled at powerhouse so failure would have no primary effects.*

Signature(s) of person(s) completing this section

FORM F - SURFACE CONDITION OF CONCRETE
(From ACI Report 65-67)

1. Identify the feature for which this section applies. ___________

1993 Repair to Secondary Spillway at upstream end of power canal

2. General condition of concrete

(X) Good
( ) Satisfactory
( ) Poor

Remarks: ___________

3. Cracks ( ) Yes (X) No

Describe ___________

Direction
( ) Longitudinal
( ) Transfers
( ) Vertical
( ) Diagonal
( ) Random

Maximum Width
( ) fine (less than 1 mm or 3/64")
( ) medium (1 mm to 2 mm or 3/64" to 5/64")
( ) wide (more than 2 mm or more than 5/64")

Type
( ) Pattern cracking
( ) Checking
( ) Hariline cracking
( ) D-cracking

Mineralization
( ) Leaching
( ) Stalactites
( ) Stalagmites

4. Scaling ( ) Yes (X) No
Describe ___________

4. (Cont'd)

Severity
- ( ) Light (C.A. not exposed)
- ( ) Medium (1/2 to 1 cm or 13/64" to 25/64", C.A. exposed)
- ( ) Severe (C.A. clearly exposed and stands out)
- ( ) Very severe (loss of C.A.)

5. Popouts ( ) Yes (X) No

Describe ______________________________

____

____

Size
- ( ) Small (less than 1 cm diameter or 25/64" diameter)
- ( ) Medium (1 to 5 cm diameter or 25/64" to 2" diameter)
- ( ) Large (more than 5 cm diameter or 2" diameter)

6. Spalls ( ) Yes (X) No

Describe ______________________________

____

____

Size
- ( ) Small (less than 2 cm deep and 15 cm long or 3/4" deep and 6" long)
- ( ) Large

7. Is(are) there any?

- (X) None
- ( ) Pitting
- ( ) Dusting
- ( ) Honeycomb
- ( ) Stains
- ( ) Exposed steel
- ( ) Previous patching or other repair
- ( ) Chemical attach

7. (Cont'd)

Describe ______________________________

____

____

____

____

8. In your opinion, what is the effect of the condition of the concrete on the safety of the dam?

(X) Little or none
( ) Aesthetic problems but nothing that would effect the integrity of the structure.
( ) May create operational problems, but no safety problem
( ) If uncorrected, could eventually become a safety problem
( ) It is a safety problem that could result in a large uncontrolled release of water
( ) Other
Explain ______________________________

____

____

____

Signature(s) of person(s) completing this section

Lawrence [signature]

____

____

FORM G - GEOLOGY

The items in this report are divided into two general categories:

a. Description of the General Geology of the basin (items 1 through 14)

b. Description of site geology (items 15 through 21)

GENERAL GEOLOGY OF THE BASIN

1. Glacial ( )
   Non-glacial ( )

2. Glacial
   ( ) Till plain
   ( ) End moraine
   ( ) Outwash plain
   ( ) Combination - Explain ______________________________

   Non-Glacial
   ( ) Deeply disected
   ( ) Rather level

3. River Valley
   ( ) Deeply incised
   ( ) Shallow
   ( ) Broad
   ( ) Steep sided
   ( ) Terraced
   ( ) Meandering
   ( ) Other - Explain ______________________________

4. Topography
   ( ) Level or even
   ( ) Rolling
   ( ) Hilly
   ( ) Knob & kettle
   ( ) Other - Explain ______________________________

5. Empoundment
   ( ) Lake
   ( ) River
   ( ) Combination - Explain ______________________________

6. Soils

Origin

( ) Outwash
~~( )~~ Loess
~~( )~~ Boulder Clay
~~( )~~ Alluvial
( ) Marsh
( ) Glaciofluvial

Explain ALLUVIAL DEPOSITS ARE PRESENT IN THE RIVER VALLEY. CLAY IS IN EMBANKMENT, ORIGIN UNKNOWN.

Types

~~( )~~ Sand-gravels
~~( )~~ Clays
~~( )~~ Silts
( ) Organic
( ) Other
Explain

SANDS AND GRAVELS ARE MOSTLY ALLUVIAL DEPOSITS. CLAYS ARE PRESENT

7. Effect of Topography on Drainage

~~( )~~ Rapid
( ) Even
( ) Slow

8. Effect of Soil Type on Drainage

~~( )~~ Rapid
( ) Even
( ) Slow

9. Bedrock Geology of Basin

Formation Name AT LANESBORO - PROBABLY ONCOTA

Rock Type LIMESTONE DOLOMITE

General Depth to Rock SURFACE

Outcrops in Valley Walls LIMESTONE

10. Source of Bedrock Information

~~( )~~ Visual
( ) Well records
( ) Borings
~~( )~~ Published data

11. General Water Table

Source of water to stream flow
(—) Surface runoff
( ) Lakes, marshes
(—) Springs
(—) Ground water

12. ( ) Slumping or slides in reservoir
( ) Slumping or slides in downstream channel

13. (—) Sink holes or surface depression REPORTEDLY CAN OCCUR IN THIS AREA

14. (—) Groundwater discharge area
( ) Groundwater recharge area

SITE GEOLOGY

15. Geologic Setting

( ) Glacial
- ( ) Outwash plain
- ( ) Till plain
- ( ) End moraine

(—) Non-glacial
- (—) Deeply disected plain
- ( ) Alluvial plain

(X) Terraces
- ( ) Soil
- (X) Rock

16. Bedrock

Formation Names: DOLOMITE - PROBABLY ONEOTA

(X) Exposed
( ) Deeply buried
( ) Sandstone
(X) Limestone
( ) Shale
( ) Igneous
- ( ) Balsalt
- ( ) Granite
- ( ) Other - Explain ______

17. Abutments and Foundation

( ) Soil
Types ______________________

(X) Rock
Types Limestone

18. Seepage
( ) Pervious soils
(X) Bedding planes or joints in rock
( ) Fracture zones in rock

19. Rock Structure

a. Bedding
(X) Horizontal
( ) Dipping
(X) Massive bedded
( ) Medium bedded
( ) Thin bedded

b. Bedding Planes
(X) Open
( ) Closed

c. Joints
( ) Close spaced
( ) Widely spaced
( ) Direction and inclination to structure

____

( ) N/A - Explain ______________________

____

d. Bedding Planes
(X) Open
( ) Closed

e. Hardness of Rock
( ) Soft
( ) Medium
( ) Hard

f. Cementation
(X) Well cemented
( ) Poorly cemented
( ) Non-cemented

20. On a separate sheet of paper draw an approximate geologic profile along the centerline of structure showing assumed or known soil and rock profile in the abutment and foundation areas. Identify major soil types or rock formations.

21. Based on visual observations made at the site list the geologic conditions which are believed to represent major potential threats to the safety of the dam.

(1) EROSION POTENTIAL OF BEDROCK

(2) ______

(3) ______

(4) ______

(5) ______

(6) ______

Signature(s) of Person(s) completing this section

Philip B Solberg

[illegible]

______

STATE ID.	SEQ NO.	RIV DIV	PRIMARY ST CO CD	SECONDARY ST CO CD	NAME OF DAM	LAT	LONG	REPORT DATE
MN	00517	NCD	MN 045 01		~~ROOT RIVER~~ LANESBORO DAM	4343.0	9158.7	15JUL78 ~~18JAN74~~

POPULAR NAME	NAME OF IMPOUNDMENT
	MILL POND

REG	BA	RIVER OR STREAM	NEAREST DS CITY	DIST	POPULATION
07	05	SOUTH ~~NORTH~~ BRANCH ROOT RIVER	LANESBORO	0	850

TYPE OF DAM	YR-COM	PURPOSES	S-HGT	H-HGT	MAX-STR	NOR-STR	
PG	1868	H	~~30~~	34 ~~25~~	1000 ~~306~~	110 ~~296~~	QUADIX-22-B

-----REMARKS-----REMARKS-----REMARKS-----REMARKS-----

24-26-27-ESTIMATED CONSIDERED HAZORDOUS FS-HARZA BULL-20 STR-24 103 10

H	CREST	T	WDTH	DISCH	VOLUME	POWER I/P		NAVIGATION LOCKS
1	193 ~~150~~	U ~~C~~	143 ~~150~~	16700 ~~4000~~		..3	..3	

OWNER	ENGINEERING BY	CONSTRUCTION BY
CITY OF LANESBORO	~~LANESBORO~~	~~LANESBORO~~

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
~~NONE~~	~~NONE~~	DNR-DIV OF WATERS	DNR-DIV OF WATERS

INSPECTION BY	INSP DATE	AUTHORITY FOR INSPECTION
BARR ENG CO ~~DNR-DIV OF WATERS~~	30MAY78 ~~11SEP78~~	PL 92-367 ~~MN STATUTES CHAP 105~~

-----REMARKS-----REMARKS-----REMARKS-----REMARKS-----

APPENDIX B

HYDRAULIC AND HYDROLOGIC CHECKLIST

NATIONAL DAM SAFETY PROGRAM

HYDROLOGY AND HYDRAULICS STUDY CHECK LIST

Name of Dam LANESBORO State MINNESOTA County FILLMORE

River SOUTH BRANCH ROOT RIVER Nearest Downstream Town LANESBORO

1. General Data

Drainage area 297 sq. mi.

Total length of longest watercourse (L) 56 miles*

Fall of basin from the farthest point to the dam 560 feet*

Average slope of the basin .0017 feet/feet*

Time of concentration (t_c) 24 hours*

Type of cover (develop by approximate estimate, not precise computation)

Urban	5	%
Forest	10	%
Grassland	30	%
Crop	55	%
Lake and swamps	0	%
Other	0	%
Explain		
Total	100	%

Frequency curve: Yes ✓ No ____ Incl ✓

Maximum probable index rainfall 25.1 inches in 6 hours

* See page 14-7 of Chows, "Handbook of Hydrology" for definition.

Sheet 2 of ____
Date ____
ID MN 517

Current spillway design flood: Yes___ ~~No~~✓ Peak Q_____cfs

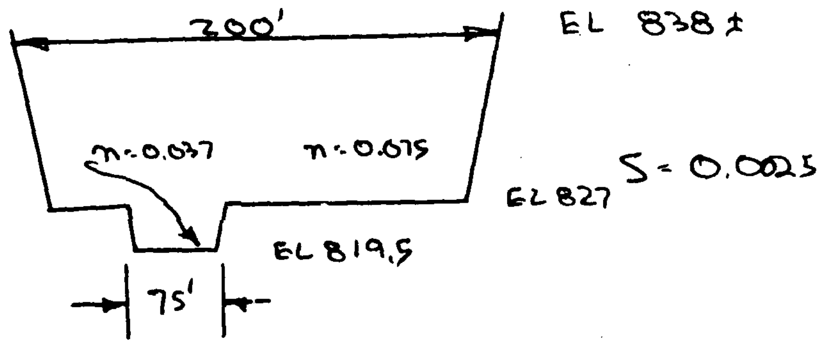
Current spillway design flood hydrograph: Yes✓ ~~No~~___ Incl#___

Other pertinent data: PMF

Downstream Channel X - Sections: ~~Yes~~✓ No___ Incl#___

Rough sketches of cross-section downstream of dam showing distance below the dam, channel and overbank dimensions, n values, and slope.

1000' DOWNSTREAM



Date __________
ID MN 517

2. Channel capacity in critical downstream reach 3840 cfs.

3. Flood Plain Development

First 1000 feet downstream NO HOUSES - RR BRIDGE

Between 1000 feet and 1 mile LARGE DEVELOPMENT - MANY RESIDENCES

Between 1 mile and 5 miles RURAL - WHALAN IS 6.1 MI DOWN STREAM PROBABLY AFFECTED VERY LITTLE

Other critical reach

4. Description of outlet works, including stilling basin. Give plan, profile, cross-section sketches with important elevations, dimensions, and water surfaces. Plans available: Yes _____ No ✓ Incl# _____

Capacity:	cfs	% frequency
with _____ ft. of freeboard		
without freeboard		
normal operating capacity at _________ elevation		

5. Description of service spillway, including stilling basin. Give plan, profile, cross-section sketches with important elevations, dimensions, and water surfaces. Plans available: Yes _____ No ✓ Incl# _____

Capacity:	cfs	% frequency
with _____ ft. of freeboard		
without freeboard	16,700	6
normal operating capacity at 847.5 t elevation	150	

6. Description of emergency spillway, including stilling basin. Give plan, profile, cross-section sketches with important elevations, dimensions, and water surfaces. Plans available: Yes _____ No ✓ Incl# _____

Capacity:	cfs	% frequency
with _____ ft. of freeboard		
without freeboard		
normal operating capacity at _________ elevation		

Sheet 4 of ____
Date __________
ID MN 517

7. Storage capacity curves of reservoir: Yes ✓ No ____ Incl# ____

Elevation	Area (acres)	Capacity (ac-ft)
847	31	108
851	31	232
860	304	2032
865	357	3685

8. As built design flood: N/A

Outlet works ______ cfs. Service spillway ______ cfs.

Emergency spillway ______ cfs. Project ______ cfs.

Design freeboard ______ feet. Expected wave ______ feet.

9. Headwater rating curve: Yes ✓ No ____ Incl# ____

10. Tailwater rating curve: Yes ✓ No ____ Incl # ____

11. Downstream channel material SILT ; erodible: Yes ✓ No ____

12. Erosion Protection:

Upstream embankment face - EARTH FILL

Downstream embankment face - BEDROCK

At stilling basin - BEDROCK

Downstream - BEDROCK WITH SILT PLAIN

13. Critical depths at stilling basin: N/A

[illegible] disch[illegible]

Q = _____ cfs, d_1 = _____, d_2 = _____ ft _____ elev., tailwater elev._____.

As built project design spillway capacity:

Q = _____ cfs, d_1 = _____, d_2 = _____ ft _____ elev., tailwater elev._____.

Other critical condition:

Q = _____ cfs, d_1 = _____, d_2 = _____ ft _____ elev., tailwater elev._____.

Current spillway design flood:

Q = _____ cfs, d_1 = _____, d_2 = _____ ft _____ elev., tailwater elev._____.

14. Critical heads across structure: Top of dam elev. 855.6

Elev. bottom channel downstream 822 ±

At normal operating pool: Elev. _____	Q	Tailwater Elev.	Head
No flow	_____	NA	
Normal =	_____		
Design =	_____		
Spillway =	_____		
Other Critical =	_____		

At full pool: Elev. _____	Q	Tailwater Elev.	Head
No flow	_____	NA	
Normal =	_____		
Design =	_____		
Spillway =	_____		
Other Critical =	_____		

At as built spillway capacity pool: N/A	Q	Tailwater Elev.	Head
Elev. ____			
No flow	____		
Normal =	____		
Design =	____		
Spillway =	____		
Other Critical =	____		

At current spillway design flood:	Q	Tailwater Elev.	Head
Elev. ____			
No flow	-	825.0 ±	22.0 ±
Normal =	150	825.0±	22.5 ±
Design =	120,000	U	U
Spillway =	16,700	836.8	18.8
Other Critical =	____		

15. Sensitivity analysis of estimated spillway design flood (SDF): NA

120% SDF Pool Elev. ____. Tailwater Elev. ____ H ____

80% SDF Pool Elev. ____ Tailwater Elev. ____ H ____

16. Will routing the current spillway design flood through the pool significantly (by more than 10%) attenuate the peak? Yes ____ No ✓

a. Results of routing spillway design flood through pool.

(1) Performed ____ See Incl# ____

(2) Not performed ✓ Reason: POOL VOLUME VERY SMALL

Sheet 7 of ____
Date ____
ID MN 517

b. Dam overtopping and/or breeching analysis.

(1) Yes ____ See Incl# ____

(2) No ____ Reason: ____

c. Summary of impacts of spillway design flood evaluation.

See Incl# ____.

17. Does stilling basin adequately dissipate energy over expected range of discharge? THE ENERGY IS DISSIPATED BY A PLUNGE POOL - NO FORMAL STILLING BASIN EXISTS - SCOUR INDICATES ENERGY IS EFFECTIVELY DISSIPATED

18. At existing spillway capacity is erosion downstream expected?
YES, SCOUR HOLE WILL PROBABLY DEEPEN

19. Will erosion jeopardize safety of structure?
IF SCOUR HOLE GETS TOO CLOSE TO BASE OF STRUCTURE, IT MIGHT AFFECT THE SAFETY OF THE DAM.

20. Does stilling basin adequately dissipate energy for spillway design flood? YES, HOWEVER EROSION AND SCOUR WILL OCCUR

21. For spillway design flood is erosion downstream expected?
SILT BANKS WILL ERODE EASILY

22. Will erosion jeopardize safety of structure?
PROBABLY NOT

23. Has downstream development constrained use of any outlet works or spillway? NO

24. Has downstream development constrained design operating plan?
NO, THE HYDRAULIC OPERATING PROCEDURES ARE VERY LIMITED

Sheet 8 of ____
Date ____
ID MN 517

25. Summary of Findings:

a. Adequacy of spillway and top of dam -
THE SPILLWAY IS INADEQUATE TO PASS A STORM OF GREATER DISCHARGE THAN THE 18 YEAR STORM OR 1/7 OF THE PMF

b. Consequences of overtopping by current spillway design flood related to breeching dam, downstream flood wave and hazard -

SEE SECTION 3.4

c. Adequacy of outlet works and control gates -
THESE ARE NOT EXPECTED TO BE USED IN FLOOD CONTROL

d. Adequacy of stilling basins -
PLUNGE POOL APPEARS TO BE ADEQUATE TO DISSIPATE ENERGY

e. Adequacy of downstream erosion protection -
BEDROCK APPEARS STABLE, SILT PROBABLY MOVES WITH FLOODS

f. Adequacy of erosion protection at dikes, embankment, or dam -
ONCE THE INTAKE STRUCTURE IS OVERTOPPED, EROSION OF EMBANKMENTS WILL OCCUR. EFFECTS OF THE EROSION COULD CAUSE A FAILURE

g. Upstream urbanization potential and consequences -
THE SIZE OF THE EMPOUNDMENT HAS BEEN GREATLY REDUCED BY SILTATION AND BY URBANIZATION - NOW JUST A CHANNEL

h. Downstream urbanization potential and consequences -
DOWNSTREAM DEVELOPMENT IS VERY CLOSE TO THE RIVER.
DAMAGE POTENTIAL IS VERY HIGH

i. Consequences of dam failure at full pool and zero discharge related to downstream floodwave and hazard -

SEE SECTION 3.4

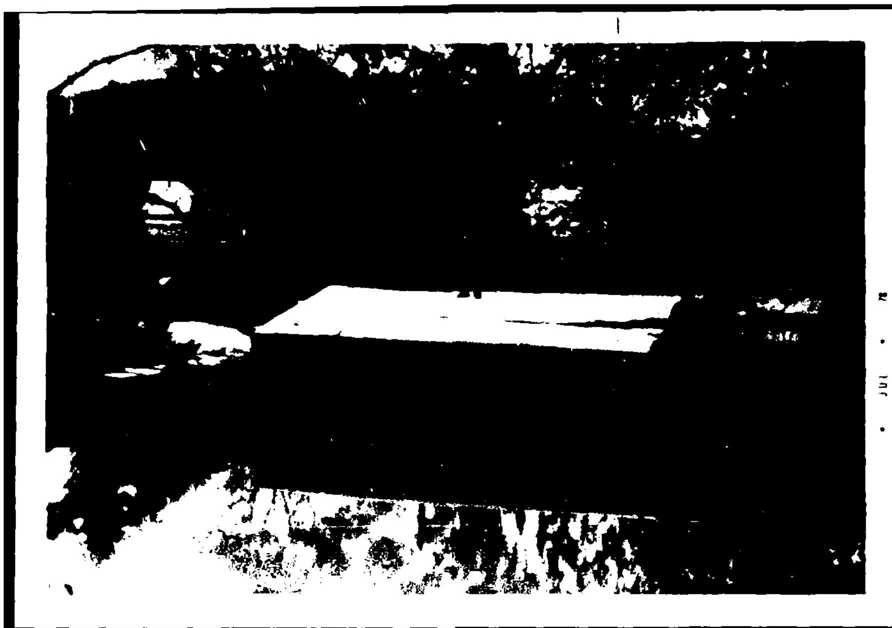
NOTE: Mark U for unknown - N/A for not applicable

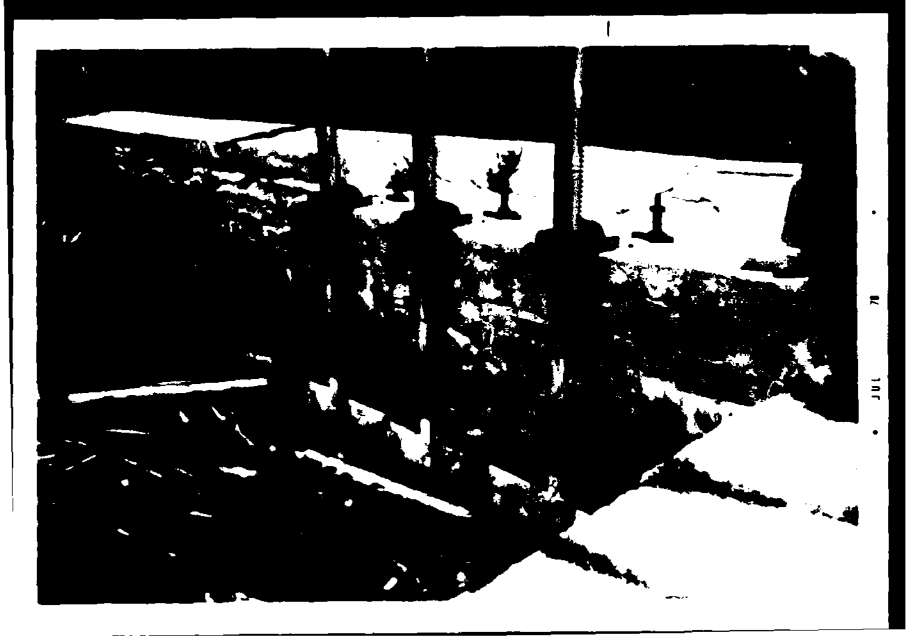
APPENDIX C

PHOTOGRAPHS

1. Primary Spillway, Canal Intake Structure, Non-Overflow Section, Canal - Picture taken 30 May 1978. Photograph taken from rail-road bridge looking upstream. Note: 1) silted in old lake bed in background; 2) flow of spillway on far left; 3) vege-tation upstream and downstream of non-overflow spillway; 4) large cracks in canal intake structure.

2. Canal Intake Structure - Picture taken 17 May 1978. Photo-graph taken from left abutment looking downstream. Note: 1) three wooden gates in center; 2) exposed masonry left side of structure; 3) large cracks throughout structure; 4) upstream training wall in right foreground with gravity blocks in place.





3. Headrace Intake Structure, Downstream Training Wall, Secondary Spillway, Headrace - Picture taken 30 MAY 78. Photograph taken from left abutment. Note: 1) large cracks in headrace intake structure (lower left corner); 2) trees downstream of downstream training wall; 3) portion of gate structure upstream of secondary spillway; 4) new concrete facing on downstream face of secondary spillway; 5) railroad bridge and grade downstream over headrace.

4. Secondary Spillway, Left Masonry Abutment to Secondary Spillway, Earth Embankment - Picture taken 17 MAY 78. Photograph taken from bedrock outcropping downstream of primary and secondary spillways. Note: 1) seepage through left masonry abutment to secondary spillway; 2) water at base of secondary spillway.

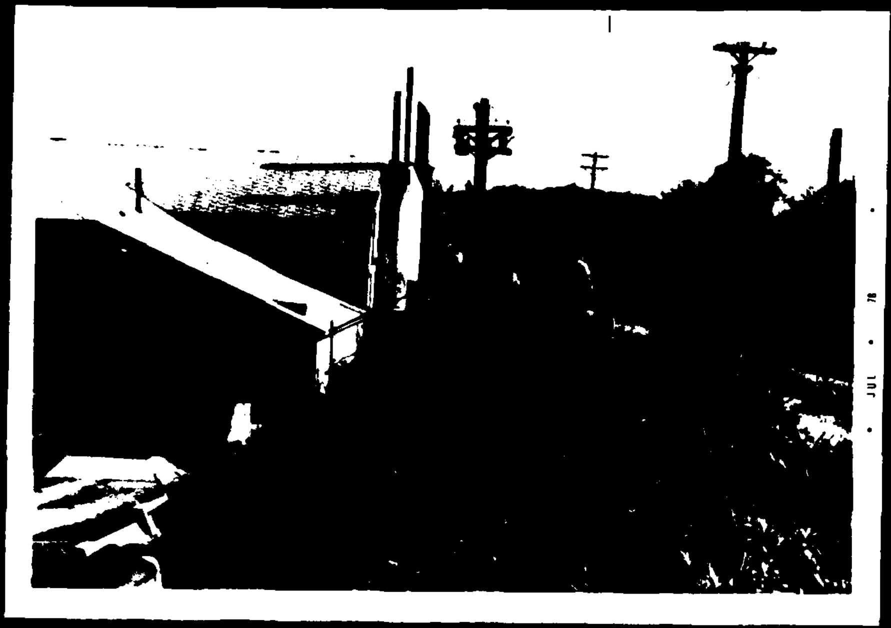
5. Primary Spillway, Canal Spillway, Left Abutment to Canal Spillway, Earth Embankment, Canal - Picture taken 30 May 1978. Photograph taken from railroad bridge over canal. Note: 1) irregular flow over primary spillway; 2) trees growing near junction of non-overflow section and bedrock outcropping; 3) riprap upstream of earth embankment; 4) the eroded location is directly in front of the individual.

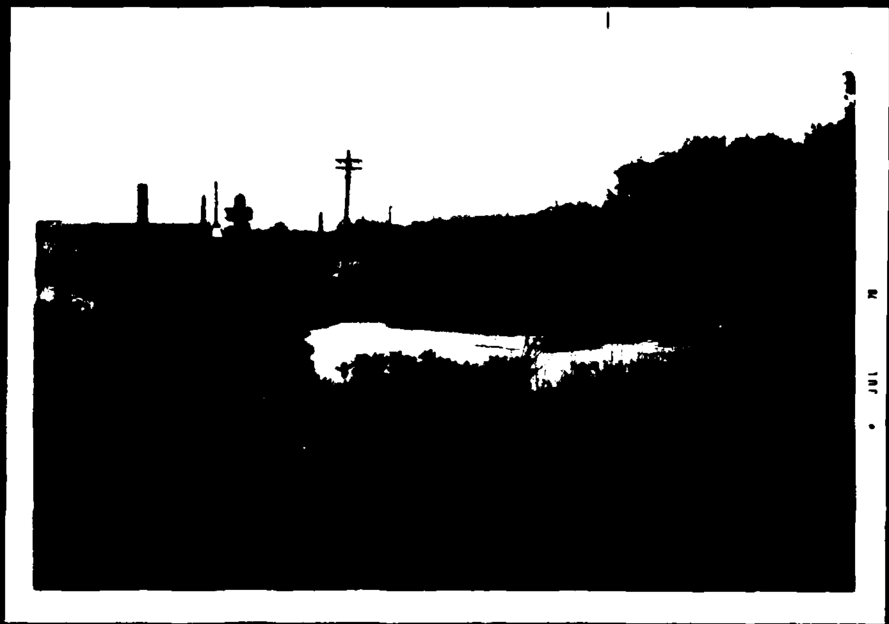
6. Left Abutment Canal Spillway - Picture taken 30 May 1978. Photograph taken from top of canal spillway looking at downstream face of left abutment canal spillway. Note: 1) large quantity of flowage through and behind abutment.


JUL • 78

7. Powerhouse - Picture taken 30 May 1978. Photograph taken from end of canal looking upstream. Note: 1) powerhouse of immediate left; 2) boiler room immediately behind powerhouse; 3) old railroad grade serving as top of embankment; 4) powerhouse inlet to right of embankment; 5) one of two possible old turbine shafts in foreground left of wall.

8. Canal - Picture taken 17 May 1978. Photograph taken from railroad grade downstream of canal looking upstream. Note: 1) abandoned intake structure in line with possible old turbine shaft; 2) powerhouse in background with inoperable gate structure; 3) canal embankment separating race from mill pond (right side of picture).





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